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NYMPHS OF NORTH AMERICAN PERLODINAE GENERA (PLECOPTERA: PERLODIDAE)¹

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ABSTRACT.—Nymphs of the type or other representative species of the 22 North American Perlodinae genera are comparatively described and illustrated for the first time. The first complete generic key for the subfamily incorporates recent nymph discoveries and revisions in classification. References to all previous nymph descriptions and illustrations and major life cycle and food habits studies are given for the 53 North American species in the subfamily, and a listing of species and their current distributions by states and provinces is provided for each genus. The previously unknown nymph of *Chernokrilus misnomus* is described and illustrated.

Ricker (1952) provided the first comprehensive study of the stonefly family Perlodidae, based largely on adult genitalia and mesosternal characters, and on gills, mesosternae, and mouthparts of known nymphs. He recognized three subfamilies, Isogeninae, Isoperlinae, and Perlodinae. Stark and Szczytko (1984) discussed the subsequent disparate classifications of the family by Zwick (1973) and Ricker and Scudder (1975), and, based upon a comprehensive SEM study of eggs of world genera: (1) reaffirmed Zwick's recognition of only two subfamilies, Isoperlinae and Perlodinae, and (2) recognized three tribes of the Perlodinae, Arcynopterygini, Diploperlini, and Perlodini, containing 36 genera.

The nymphs of Perlodidae have remained relatively poorly known and/or incompletely described and illustrated, and therefore have not been comparatively studied. Ricker (1952) included notes on nymphal mouthparts, mesosternae, and gills, and a few illus-

trations of mouthparts (four genera), and his subsequent illustrated key to nymphs (Ricker 1959) utilized essentially those same characters. However, those papers are now incomplete since they did not include nymphs of the currently recognized genera *Calliperla* Banks, *Cascadoperla* Szczytko & Stewart, *Clioperla* Needham & Claassen, *Chernokrilus* Ricker, and *Oconoperla* Stark & Stewart. Nymphs of *Osobenus yakamae* (Hoppe) and *Rickera sorpta* (Needham & Claassen) [= *venusta* Jewett] were briefly described by Jewett (1955) and included in Ricker's (1959) key. *Calliperla* and *Chernokrilus* nymphs have remained unknown, and, at the time of the two definitive Ricker papers (1952, 1959), *Cascadoperla* (Szczytko & Stewart 1979) and *Clioperla* (Szczytko & Stewart 1981) were included in the *Isoperla*, and *Oconoperla* (Stark & Stewart 1982) had not been discovered. Szczytko and Stewart (1984b) described the nymph of *Calliperla luctuosa* (Banks), and the poorly known

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nymph of *Rickera sorpta* (Needham & Claassen). Based upon study of all life stages, they moved the genus *Rickera* from Isoperlinae to Perlodinae, and recognized seven genera in the Isoperlinae (*Bulgaroperla*, *Calliperla*, *Cascadoperla*, *Clioperla*, *Isoperla*, *Kaszabia*, and *Mesoperlina*). Shepard and Stewart (1983) described the nymphal gills of all current Perlodidae generic types except *Chernokrilus*, which is gill-less (see description below).

Our objective in this study was to provide an updated account of nymphs of the 22 North American Perlodinae genera, utilizing recent nymph discoveries and revisions in classification. The first complete generic key that follows is therefore based upon our study of known nymphs. The comparative descriptions and illustrations under each genus are based upon nymphs of the type species, except in *Cultus* Ricker and *Isogenoides* Klapálek, where good correlated nymphs of the type species were unavailable, and *Diura* Billberg and *Megarcys* Klapálek, whose types are distributed outside North America. In these four instances, common North American species whose nymphs were considered representative of the genus were used. This approach provides a complete treatment of nymphs of the 9 monospecific genera, and a useful morphological baseline for the eventual exhaustive study and analyses of nymphs of all species in the remaining 13 genera. The only comparative studies of all nymphs in a genus have been for *Diploperla* (Kondratieff et al. 1981), *Helopicus* (Stark & Ray 1983), and *Hydroperla* (Ray & Stark 1981). Accounts of each genus below also include: (1) references to all previous descriptions of North American nymphs in each genus and major life cycle and food habits studies, and (2) a list of current North American species and their known distributions by states and provinces. We began collecting and rearing nymphs of Perlodidae in 1978, giving par-

ticular attention to those that were unknown, rare, and inadequately described and illustrated. The collection of correlated nymphal study material necessary for this undertaking was successfully completed in early 1983.

MATERIALS AND METHODS

Mature nymphs of type species and others were correlated by one or more of the following methods: (1) reared in styrofoam containers in the field (Szczytko & Stewart 1979), (2) transported on ice in styrofoam containers by auto or aircraft then reared in an environmental chamber or living stream at simulated stream temperatures, or (3) heated gently in a 10% KOH solution and nymphal cuticle removed to reveal underlying adult genitalia.

Extracted mouthparts were prepared for SEM study (Stark & Stewart 1981) and photographed using an AMR 1000 scanning electron microscope at the University of Mississippi Dental School. Drawings were then made of mandibles and maxillae from the SEMs, making sure that setation and other illustrated characters could be seen with a stereo dissecting microscope. Nymphs were studied under a Wild M-5A stereomicroscope, and gills, front legs, mesosternae, abdominal venters, and cerci were drawn using a Wild Drawing Attachment. Head-pronotal patterns were prepared on stippleboard, and carbon dust habitus drawings were prepared from our pencil sketches.

Key to Subfamilies of Mature North American Perlodidae Nymphs

There are no known characters that uniformly separate nymphs of Isoperlinae from Perlodinae; however, the following key should be helpful.

- 1. Gills absent; lacinia bidentate (except in few eastern *Isoperla* species) and sometimes quadrate in shape; abdomen of *Calliperla*, *Cascadoperla* and most *Isoperla* with dark, longitudinal stripes Isoperlinae
- Combinations of submental, cervical, and thoracic gills present or absent; lacinia unidentate or bidentate and triangulate in shape; Ab without longitudinal stripes (except *Osobenus*) Perlodinae

Key to the 22 Genera of
North American Perlodinae Nymphs

Geographic range of each genus is indicated by the following coded abbreviations (after Baumann 1976); PNA—Pan-North America (widely distributed eastern and western); ANA—Amphi-North America (distinct eastern and western populations, usually in northern latitudes); NNA—Northern North America (distributed widely across northern

latitudes of the continent); WNA—Western North America (Rocky Mountains, westward); ENA—Eastern North America (Mississippi Valley, eastward); PNW—Pacific Northwest; SW—Southwest; IW—Intermountain West; NE—Northeast; SE—Southeast.

Illustrated characters referenced in the key are indicated by arrows on appropriate Figs. 1–22.

1. Gills present on 2 or more thoracic segments (Figs 12 F, E, 14 D, F) 2
- Gills absent from thoracic segments 5
2. Prothoracic gills present (Figs. 12 F, 16 F) 3
- Prothoracic gills absent (Fig. 20 F) *Setvena*
3. Lateral abdominal gills present on segments 1–7 (Fig. 14 D) *Oroperla*
- Abdominal gills absent 4
4. Anterior prothoracic gills (appearing as cervical) present, in addition to anterior supracoxal gills (Fig. 16 F) *Perlinodes*
- Prothorax with only anterior supracoxal gills (Fig. 12 E) *Megarcys*
5. Lacinia unidentate (Figs. 10 C, 18 C, 19 B) 6
- Lacinia bidentate (Fig. 1 B) 8
6. Lacinia broad basally, abruptly narrowed into a long, terminal spine (Fig. 18 C):
mature nymph < 10 mm; ENA *Remenus*
- Lacinia gradually narrowed from base to terminal spine (Figs. 10 C, 19 B); mature
nymph > 15 mm; WNA 7
7. Mesosternal furcal pits connected by transverse anterior suture (Fig. 19 E); PNW *Rickera*
- Mesosternal furcal pits without transverse anterior connecting suture (Fig. 10 E)
WNA *Kogotus*
8. Femora and tibia with long setal fringe; (Figs. 1 D, 3 D) posterolateral margins of
pronotum smoothly rounded (Fig. 1 A) 9
- Femora and tibia without long setal fringe (Fig. 13 D); posterolateral margins of
pronotum notched (Fig. 13 A); SE *Oconoperla*
9. Mesosternum with median longitudinal suture connecting fork of Y-arms with a
transverse suture (Fig. 9 F) *Isogenoides*
- Mesosternum without such median longitudinal suture 10
10. Occiput and/or anterolateral prothoracic margins with row of short, stout setae
(Figs. 1 A, 2 A) 11
- Occiput and/or anterolateral prothoracic margins without row of short, stout setae; a
few long setae may be present (Figs. 3 A, 15 A) 20
11. Mesosternal Y-arms meet or approach anterior corners of furcal pits (Figs. 1 F, 6 F,
21 F); mandibles deeply cleft (Figs. 1 C, 6 B) 12
- Mesosternal Y-arms meet or approach posterior corners of furcal pits (Figs. 2 E, 11 F,
17 F); mandibles not deeply cleft (Figs. 2 B, 11 B, 17 B) 14
12. Apical lacinial tooth short, much less than 1/3 total outer lacinial length (Fig. 6 C);
ventral submarginal lacinial setae extending well onto apical tooth as a close-set
row (Fig. 6 C); WNA *Frisonia*

- Apical lacinial tooth long, greater than $\frac{1}{3}$ total outer lacinial length (Figs. 1 B, 21 C); ventral submarginal lacinial setae end at inner base of apical tooth (Figs. 1 B, 21 C) 13
- 13. Inner cusps of left mandible unserrated (outermost cusp with indistinct inner serrations) (Fig. 1 C) and serrations usually indiscernible on all cusps of right mandible; occipital area of head with sinuate spinule row, but no mesal, long, white, silky hairs; NNA *Arcynopteryx*
- Some inner cusps of left mandible with shallow, indistinct serrations (Fig. 21 B) and inner serrations distinct on outermost cusp of both mandibles; mesal tufts of long, white, silky hairs usually present between occipital spinule row and ecdysial suture (Fig. 21 A); WNA *Skwala*
- 14. Apical lacinial tooth about $\frac{1}{2}$ total outer lacinial length (Figs. 15 C, 17 C) 15
- Apical lacinial tooth about $\frac{1}{3}$ or less total outer lacinial length (Figs. 8 C, 11 C) 16
- 15. Subapical lacinial tooth $\frac{1}{2}$ or less the length of apical tooth (Fig. 2 C); incomplete anterior extensions of mesosternal Y-arms present (Fig. 2 E); cerci unicolorous; PNW *Chernokrilus*
- Subapical lacinial tooth greater than $\frac{1}{2}$ length of apical tooth (Fig. 17 C); incomplete anterior extensions of mesosternal Y-arms absent (Fig. 17 F), basal cercal segments yellow, apical $\frac{1}{2}$ of cerci dark brown to black; WNA *Pictetiella*
- 16. Ventral lacinial surface with basal outer patch of more than 50 setae (Fig. 11 C); abdominal tergae generally with less than 10 short, stout intercalary setae; ENA *Malirekus*
- Ventral lacinial surface without basal outer patch of setae (Figs. 5 C, 7 C) or with fewer than 25 setae (Figs. 8 C, 22 C); abdominal tergae with more than 50 short stout, intercalary setae 17
- 17. Submental gills conspicuous, projecting portion usually 2X or more as long as their basal diameter (Figs. 7 E, 8 E) 18
- Submental gills absent or barely visible, with projecting portion no longer than basal diameter (posterolateral lobe of submentum sometimes resembles a gill) 19
- 18. Transverse dark pigment band of frons interrupted lateral to median ocellus by circular yellow areas (Fig. 8 A); ventral lacinial surface with outer patch of approximately 10 setae (Fig. 8 C); right mandible with 4 teeth; ENA *Hydroperla*
- Transverse dark pigment band of frons uninterrupted by enclosed yellow areas (Fig. 7 A); ventral lacinial surface without outer patch of setae (Fig. 7 C); right mandible with 5 teeth; ENA *Helopicus*
- 19. Marginal lacinial setal row extending from near subapical tooth to near base (Fig. 22 C); labrum with yellow longitudinal mesal band; submental gills very short if present; ENA *Yugus*
- Marginal lacinial setal row restricted to apical half (Fig. 5 C); labrum without longitudinal band; submental gills absent; ANA *Diura*
- 20. Abdomen with 2 broad dark longitudinal bands (Fig. 15 K); Y-arms of mesosternum meet anterior corners of furcal pits (Fig. 15 E); PNW *Osobenus*
- Abdomen without longitudinal dark bands; Y-arms of mesosternum meet posterior corners of furcal pits or poorly developed (Figs. 3 E, 4 E) 21
- 21. Mesosternal Y with basal stem and fork (Fig. 3 E) *Cultus*
- Mesosternal Y without stem and fork (Fig. 4 E); ENA *Diploperla*

Arcynopteryx Klapálek, s.s.

TYPE SPECIES.—*Arcynopteryx compacta* (McLachlan).

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.—(*A. compacta*) (Brink (1949; mandibles, labium/hypopharynx, labrum, maxilla, hind tarsus), Brink (1952; habitus, mandibles, labrum/hypopharynx, labrum, maxilla, hind tarsus), Despax (1951; ♂ habitus, labrum, mandibles, maxillae, labium, ♂ abdomen), Ilies (1955; habitus, maxillae, ♂ abdomen), Ricker (1952; mesosternal Y-pattern) Shepard and Stewart (1983; gills).

NYMPH DESCRIPTION.—(*A. compacta*) (Figs. 1 A–K). Body brown with dark brown markings; legs, antennae and cerci light brown. Head with light M-pattern forward of anterior ocellus, light median longitudinal bar, 2 pairs light spots inside eye and sinuate occipital row of short, stout spinules (Fig. 1 A). Antennal segments with apical circlets of very short white hairs. Laciniae triangular, with 2 terminal teeth and full row of marginal and submarginal setae; terminal tooth about 0.4 total outer length of lacinia; single axillary seta (Fig. 1 B). Left mandible deeply cleft, with acanthae at base of dorsal teeth, and median ventral patch of 12–16 setae; major ventral cusp with slight serrations, inner ventral cusps without serrations (Fig. 1 C). Length of projecting portion of submental gills about 3 times their basal diameter (Fig. 1 E). Pronotum with light lateral and mesal bands and bordered with even fringe of short spinules (Fig. 1 A). Y-arms of mesosternum reach anterior corners of furcal pits (Fig. 1 F). Wingpads with numerous irregular patches of short, stout spinules. Femora and tibiae with stout spinules, clothing hairs and fine silky posterior hair fringe (Fig. 1 D). Dorsal abdominal segments with posterior fringe of short spinules and dense short, stout intercalary spinules. Male 8th abdominal sternum with 6 mesoposterior spinules (Fig. 1 G); ♀ 8th sternum with interrupted row of mesoposterior spinules (Fig. 1 H). Cercal segments with posterior whorl of spinules, dorsal intercalary spinules, and dorsal fringe of silky hairs (Fig. 1 I, J, K).

NYMPH BIOLOGY.—Relatively poorly known. Nymphs are carnivorous, feeding heavily on chironomid larvae (Brinck 1949).

They inhabit cold streams and rivers (Brinck 1949) and high mountain or northern-latitude lakes with stony shoreline substrata (Baumann et al. 1977, Donald and Anderson 1980, K. W. Stewart unpubl. Alaska data).

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.—*Arcynopteryx compacta* — ALAS, ALB, BC, COL, MAINE, MONT, WYO, NH, NY, SASK.

Chernokrillus Ricker

TYPE SPECIES.—*Chernokrillus misnomus* (Claassen).

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.—None for any species.

NYMPH DESCRIPTION.—(*C. misnomus*) (Figs. 2 A–J). Body brown with dark brown markings, covered with flat, dark clothing hairs; legs, antennae, and cerci light brown. Head with light M-pattern forward of anterior ocellus, distinct light, T-shaped marking on anterior frons, oval spots inside eyes and back of head broken by reticulate dark lines; sinuate band of stout light occipital spinules 1–3 spinules wide (Figs. 2 A, K). Antennal segments with apical circlets of short hairs. Laciniae triangular, bidentate, with 3 or 4 marginal setae below subapical tooth and along base; marginal setae absent along middle; sparse patches of submarginal setae adjacent to marginal setae; terminal tooth about 0.45 total outer lacinial length and subapical tooth about 0.5 length of terminal tooth (Fig. 2 C) 2 or 3 long ventral setae on subapical tooth; single axillary seta. Left mandible without deep cleft, serrations of teeth or patch of median ventral setae; row of acanthae along base of dorsal teeth (Fig. 2 B). Gills absent. Pronotum dark brown with lateral light marginal band and reticulate markings; margined with short spinules (Figs. 2 A, K). Y-arms of mesosternum meet posterior corners of furcal pits and usually have anterior extensions not reaching anterior corners of furcal pits (Fig. 2 E). Meso-metanota dark with light reticulate markings and light wingpads (Fig. 2 K). Femora and tibiae with short, stout spinules, flat, dark clothing hairs and white, silky hair fringe (Fig. 3 D). Abdominal segments brown; terga with pairs of mesal and lateral light spots, posterior setal fringe and numerous short, stout intercalary

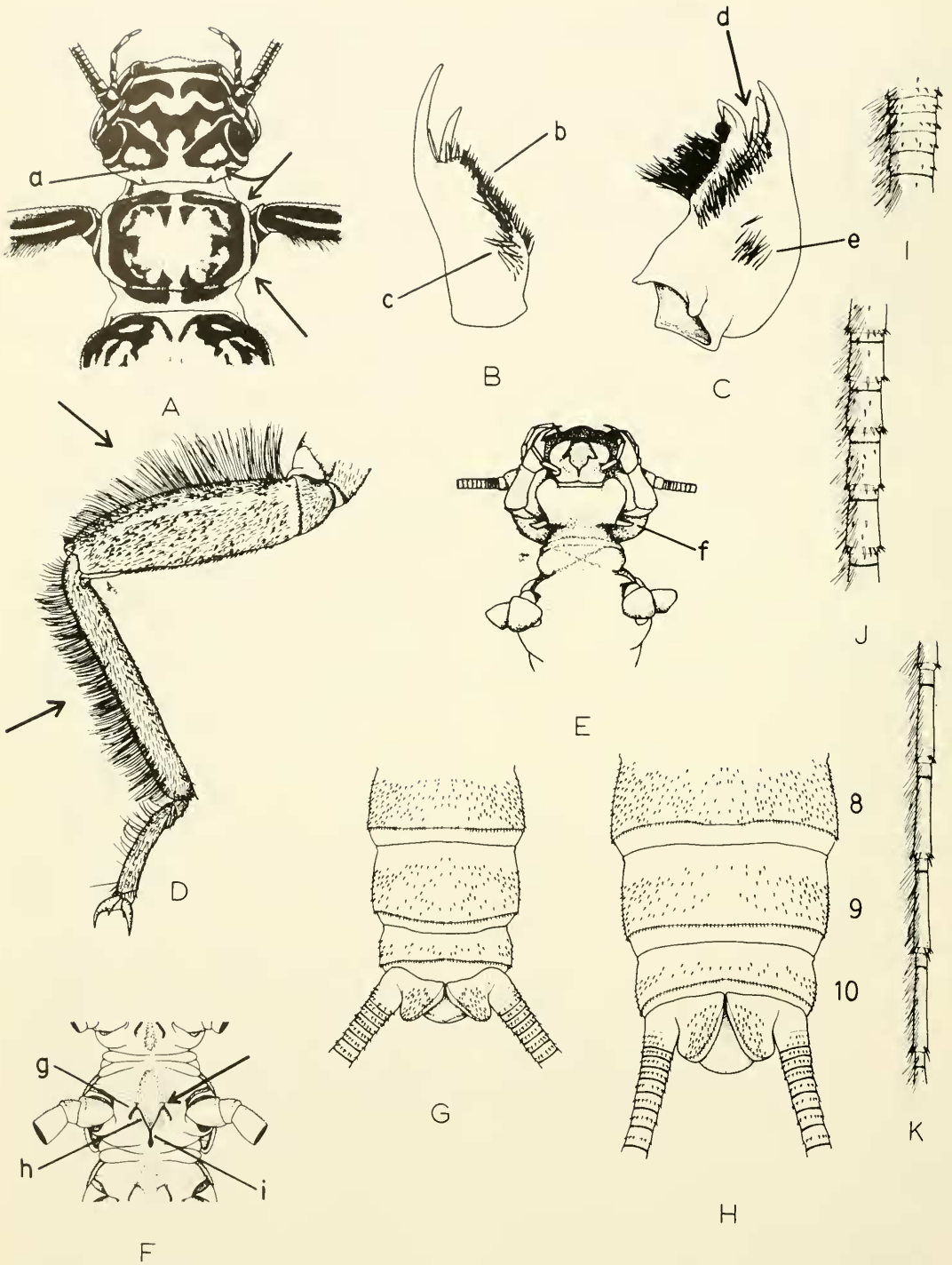


Fig. 1. Nymphal characters of *Arcynopteryx compacta*: A, head, pronotum pattern; B, right lacinia (ventral); C, left mandible (ventral); D, right front leg (anterior); E, submental gills; F, mesosternal Y-pattern; G, ♂ ventral abdomen; H, ♀ ventral abdomen; I, J, K, basal, middle, and terminal cercal segments (dorsal); a, occipital spinule row, b, marginal lacinial setae, c, submarginal lacinial setae, d, cleft of mandible, e, median ventral setal patch of mandible, f, submental gills, g, furcal pits, h, Y-arms, i, stem of Y.

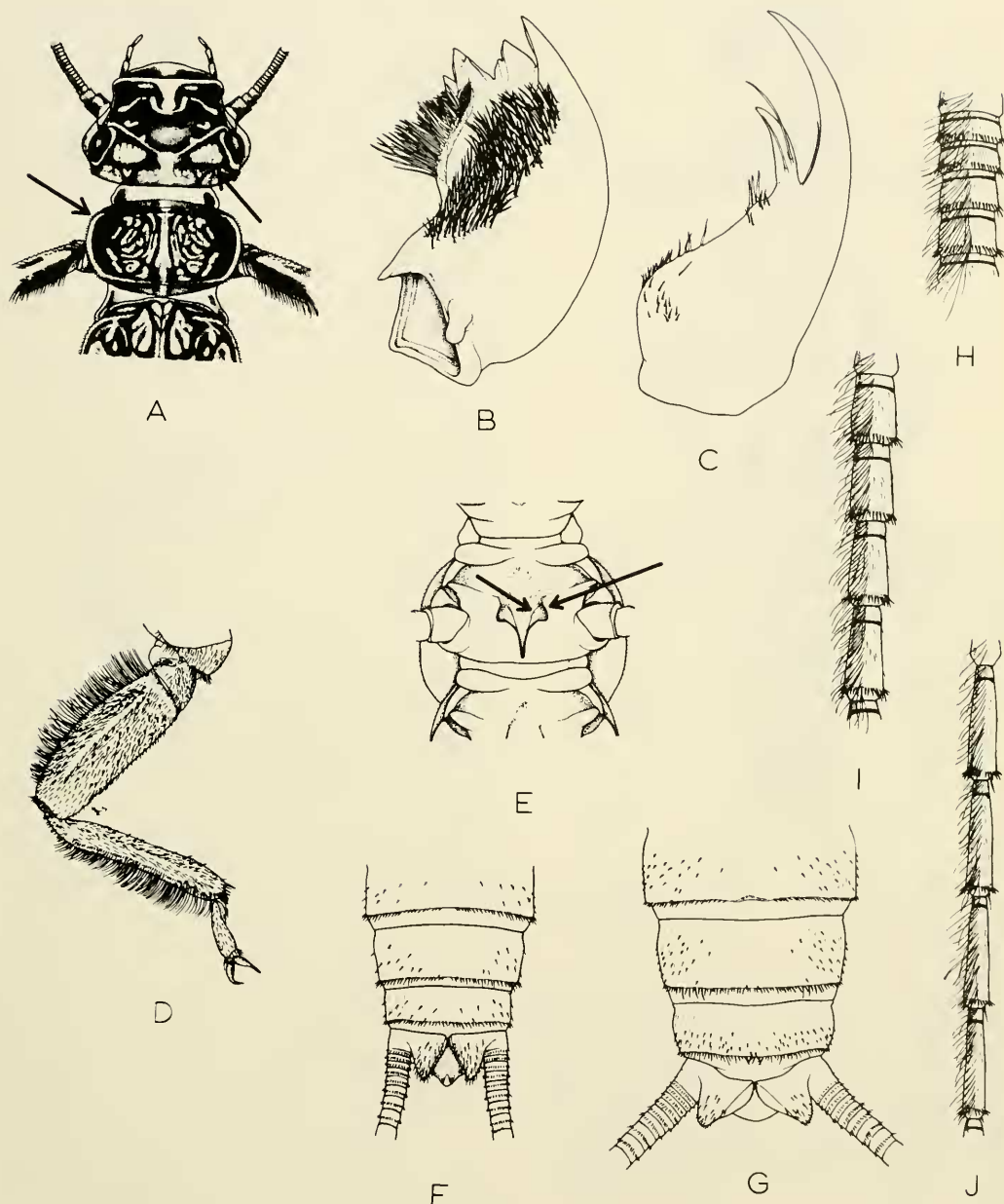


Fig. 2. Nymphal characters of *Chernokrilus misnomus*: A, head, pronotum pattern; B, left mandible (ventral); C, left lacinia (ventral); D, right front leg (anterior); E, mesosternal Y-pattern; F, ♂ ventral abdomen; G, ♀ ventral abdomen; H, I, J, basal, middle, and apical cercal segments (dorsal).

spinules (Fig. 2 K). Male 8th abdominal sternum with narrow mesal gap in posterior setal row (Fig. 2 F); ♀ 8th sternum with wide mesal gap in posterior setal row (Fig. 2 G). Cercal segments with dark anterior circular band, posterior whorl of setae; cerci with

complete vertical fringe of silky, white hairs (Figs. 2 H-J).

NYMPH BIOLOGY.—Previously unreported for any species. We collected mature, pre-emergent *C. misnomus* nymphs in early to late May in 1982 and 1983, from headwaters

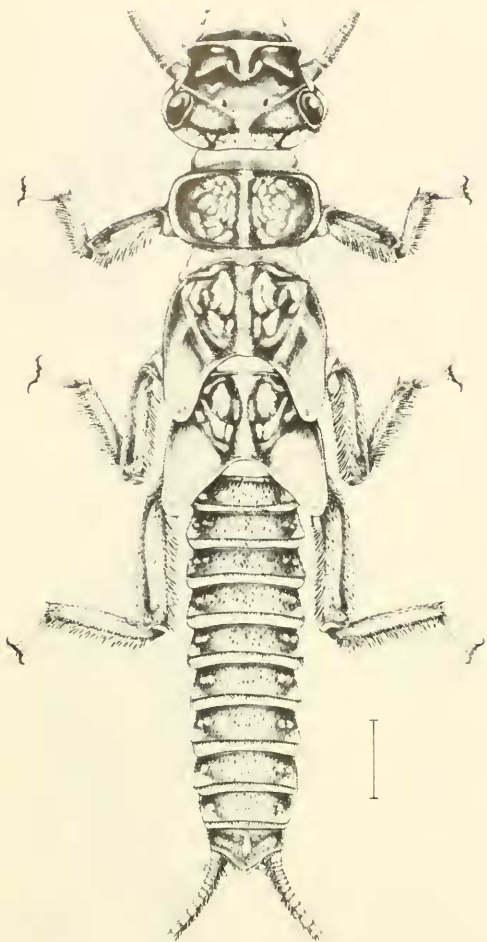


Fig. 2K. *Chernokrilus misnomus*: nymph habitus; scale line = 2 mm.

of Parker Creek, Benton County, and small steep trickles entering tributaries of the Little Nestucca River Drainage, Tillamook County, in the Coastal Range of Oregon, and in Big Spring, Siskiyou Co., California, at Mt. Shasta (7 C). Nymphs collected in Oregon after 13 May in both years were successfully field reared in styrofoam chests within 3 days.

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.—(1) *Chernokrilus erratus* (Claassen) — CA, (2) *C. misnomus* — ORE, CAL, (3) *C. venustus* (Jewett) — CAL.

Cultus Ricker

TYPE SPECIES.—*Cultus pilatus* (Frison)

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.—(1) *C. aestivalis* — Baumann et al.

(1977; maxilla), Ricker (1943) (as *Diploperla fraseri*), Claassen (1931) (as *Perla aestivalis*), (2) *C. decisus* — Claassen (1931; habitus, labrum, labium, mandible, maxillae), (3) *C. pilatus* — Frison (1942; habitus, mandibles, maxilla, labium), (4) *C. tostonus* — none.

NYMPH DESCRIPTION.—(*C. aestivalis*) (Figs. 3 A–J). Body yellow with brown markings; antennae, legs yellow, cerci brown. Head with variable pattern, usually with X-shaped pattern connecting ocelli, and light area anterior to median ocellus; light M pattern as in most Perlodinae usually indistinct; no occipital spinule row, but with long postorbital setae (Fig. 3 A). Antennal segments with apical circlets of short setae. Laciniae triangular, bidentate, with marginal setae restricted to tuft of 3 or 4 below base of subapical tooth; 3–4 scattered submarginal setae and patch of 12–14 submarginal setae near base; 2 or 3 axillary setae; terminal tooth about 0.4 total outer lacinial length, and subapical tooth 0.5 length of terminal tooth (Fig. 3 C). Left mandible without deep cleft, serrations of teeth or patch of median ventral setae; row of acanthae along inner base of dorsal teeth (Fig. 2 B). Gills absent. Pronotum with faint, irregular pattern; only 2 or 3 long hairs on corners (Fig. 2 A). Y-arms of mesosternum reach posterior corners of furcal pits, no transverse suture connecting furcal pits (Fig. 3 E). Wingpads with few setae on anterolateral corners and tips (Fig. 3 A). Femora and tibiae with scattered stout hairs; femora, tibiae, and tarsus with dense fringe, silky, white hairs (Fig. 3 D). Abdominal terga ringed anteriorly with brown band; posterior half yellow; no intercalary spinules; apical ring of setae with 2–5 longer mesal setae. Both ♂ and ♀ 8th abdominal sternae with mesoposterior interruption of posterior spinules (Fig. 3 F, G). Cercal segments with posterior whorl of short setae and complete dorsal fringe of silky, white hairs (Figs. 3 H, J).

NYMPH BIOLOGY.—Relatively poorly known for the genus. Nymphs of *C. aestivalis* inhabit a wide variety of creeks and rivers from 6950 to 9025 ft elevation in central Colorado (Knight 1965). Emergence is spread over a long period from Apr. to Aug. in the Rocky Mts. (Baumann et al. 1977, Gaufin et al. 1972); therefore, mature nymphs should be found throughout summer at various ele-

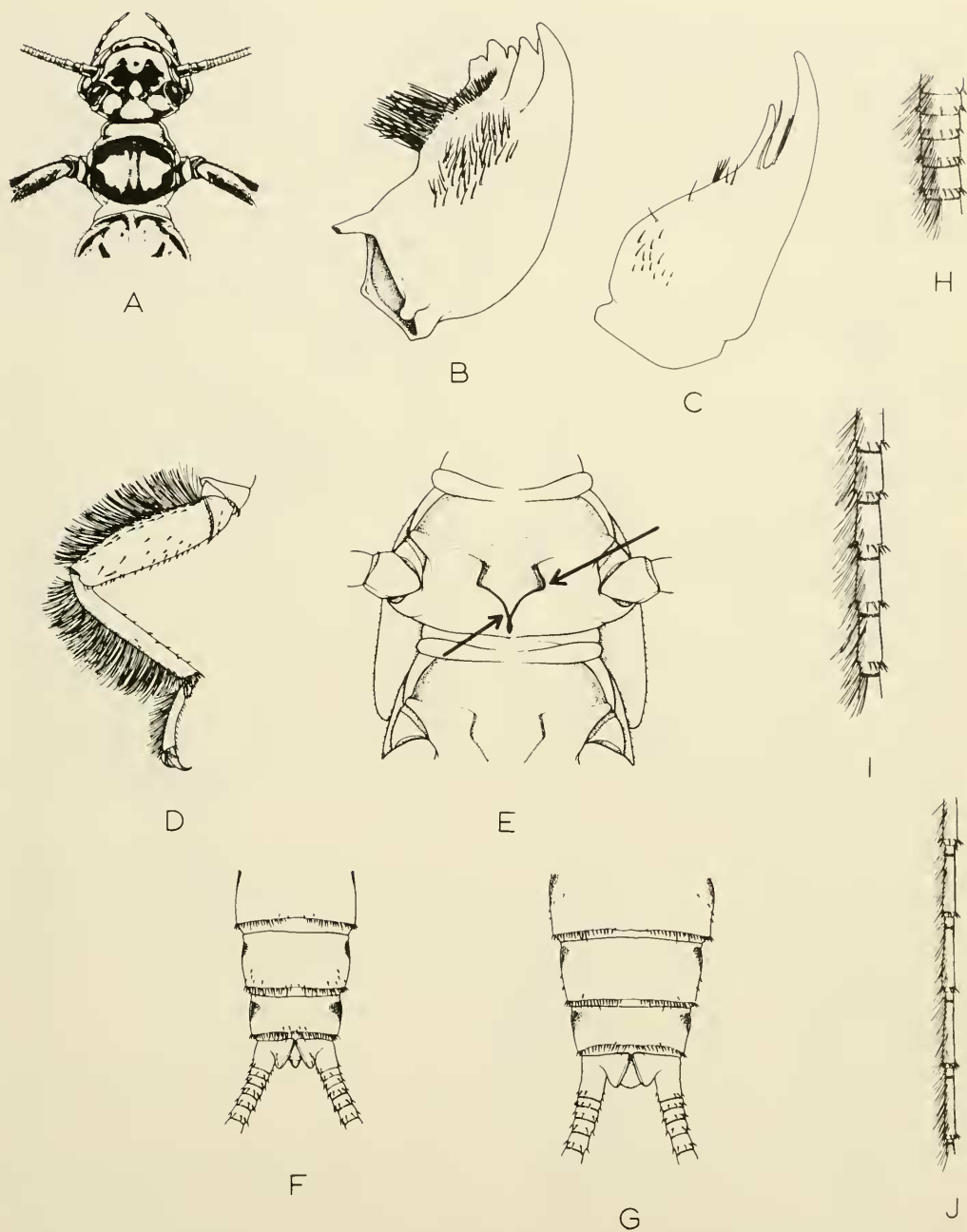


Fig. 3. Nymphal characters of *Cultus aestivalis*: A, head, pronotum pattern; B, left mandible (ventral); C, left lacinia (ventral); D, right front leg (anterior); E, mesosternal Y-pattern; F, ♂ ventral abdomen; G, ♀ ventral abdomen; H, I, J, basal, middle, and apical cercal segments (dorsal).

ventions. Eighty-two late instar nymphs from the Dolores and Gunnison rivers, Colorado, fed almost exclusively on Chironomidae and other Diptera larvae, primarily simuliids (Fuller and Stewart 1977, 1979). Nymphs of

C. decisus live in riffles in leaf packs and beneath stones, exhibit a univoltine cycle with most rapid nymphal growth from Feb. to emergence in Apr.-May, and are carnivorous (Minshall and Minshall 1966).

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.—(1) *Cultus aestivalis* (Needham & Claassen) — ARIZ, BC, COL, ID, MONT, NM, UT, WYO, YUK, (2) *C. decisus* (Walker) — CONN, GA, IND, KY, MAINE, NC, NY, ONT, PA, QUE, TN, VA, WV, (3) *C. pilatus* (Frison) — BC, CAL, ID, MONT, ORE, WN, (4) *C. tostonus* (Ricker) — BC, CAL, ID, MONT, ORE, WN, WYO.

Diploperla Needham & Claassen

TYPE SPECIES.—*Diploperla duplicata* (Banks)

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.—(1) *D. duplicata* — Hitchcock (1974; habitus), Kondratieff et al. (1981; habitus), (2) *D. morgani* — Kondratieff et al. (1981; habitus), (3) *D. robusta* — Frison (1935, labrum, mandible, maxilla, labium, habitus), Stark and Gaufin (1974), Kondratieff et al. (1981; habitus).

NYMPH DESCRIPTION.—(*D. duplicata*) (Figs. 4 A–G). Body yellow with brown markings; legs yellow, antennae and cerci brown; tiny dark, flat clothing hairs on dorsum of head, thorax. Head with brown, dark M-band connecting ocelli, with narrow light M forward of it; no distinct row or band of occipital spinules (Fig. 4 A). Laciniae triangular, bidentate with no marginal setae and only 4–6 submarginal setae; single axillary seta at base of both teeth; terminal tooth about 0.5 total outer lacinial length and subapical tooth about 0.6 length of terminal tooth (Fig. 4 C). Left mandible without deep cleft, distinct serrations of teeth (SEM 1000X shows only shallow crenulations) or patch of median ventral setae; distinct acanthae absent from base of dorsal teeth (Fig. 4 B). Gills absent. Pronotum with light, narrow lateral margins and 2 lateral longitudinal dark bands broken by reticulate light markings; narrow dark mesal line; 3–5 long setae on corners, absent laterally (Fig. 4 A). Y-arms of mesosternum incomplete, fork and stem absent, arms reaching posterior corners of furcal pits (Fig. 4 E). Meso-metanota with few short setae on anterior corners and inner margins of wingpads; irregular reticulate pattern. Femora with numerous long, stout dorsal setae; no silky hair fringe (Fig. 4 D). Tibiae with short, stout setae and golden, silky hair fringe, and tarsus

with golden dorsal hair fringe (Fig. 4 D). Abdominal terga uniform brown with apical whorl of setae; 2–4 posterolateral setae on each side of each abdominal tergum as long as succeeding segments; dorsal intercalary spinules, if present, fewer than 8 and indistinct. Cercal segments with whorl of long hairs, some as long as succeeding segment; no silky dorsal fringe (Fig. 4 F). Posterior setal row of 8th abdominal sternum of both male and female interrupted; mature female nymph with shallow mesoposterior notch (Figs. 4 G, H).

NYMPH BIOLOGY.—Relatively poorly known except for *D. robusta*. Nymphs of *D. duplicata* occupy leaf or detritus packs in small Appalachian streams, have a one-year life cycle with emergence in spring, and are carnivorous (Frison 1935). They are found above 1000 ft elevation in northwestern South Carolina (McCaskill and Prins 1968). *D. robusta* emerge in May in West Virginia, nymphs were absent May–Jul. when eggs were possibly diapausing, and young nymphs appeared in Aug., grew steadily during winter and at a rapid rate in Mar.–Apr. prior to emergence, and fed primarily on chironomids, other diptera, and mayflies, Ashley et al. (1976).

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.—(1) *Diploperla duplicata* — ALA, DEL, GA, MISS, SC, IN, VA, WV, (2) *D. morgani* Kondratieff & Voshell — VA, WV, (3) *D. robusta* Stark & Gaufin — CONN, IND, KY, OH, PA, VA, WV.

Diura Billberg

TYPE SPECIES.—*Diura bicaudata* (Linnaeus).

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.—(1) *D. bicaudata* — Nymphs from Europe have been described and illustrated by Hynes (1941, 1958), Brinck (1952), and Illies (1955), and a brief description of a single female nymph from Saskatchewan was given by Dodsall and Lemkuhl (1979), (2) *D. knowltoni* — Frison (1937), Frison (1942; mandible, maxilla, labium, habitus), Baumann et al. (1977; maxilla), (3) *D. nanseni* — Nymphs from Europe have been described and illustrated by Brinck (1949, 1952) and Saltveit (1978).

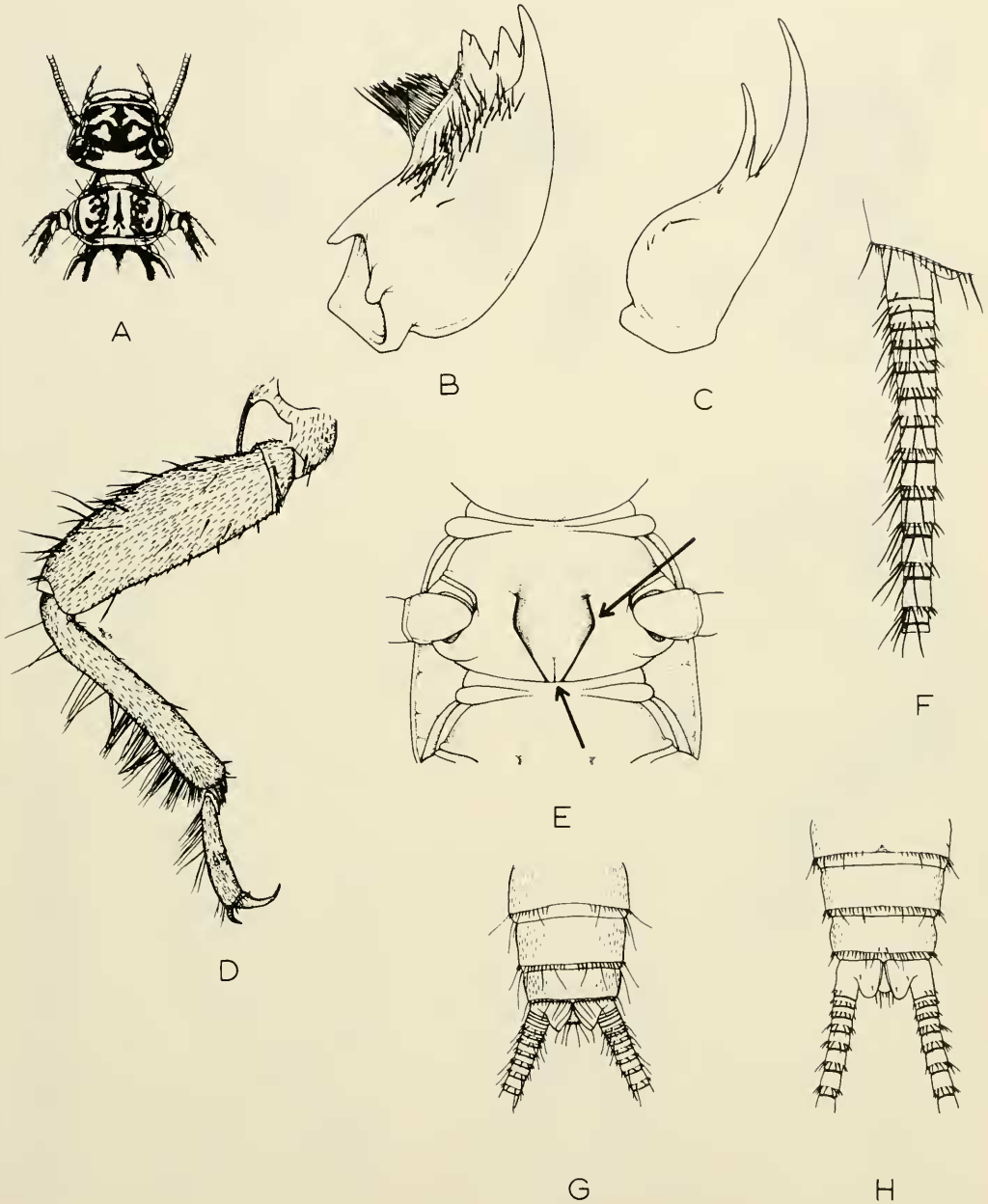


Fig. 4. Nymphal characters of *Diploperla duplicata*: A, head, pronotum pattern; B, left lacinia (ventral); C, left mandible (ventral); D, right front leg (anterior); E, mesosternal Y-pattern; F, basal segments of left cercus (dorsal); G, ♂ ventral abdomen; H, ♀ ventral abdomen.

NYMPH DESCRIPTION.—(*D. knowltoni*) (Figs. 5 A–J) Body yellow to light brown with brown markings; antennae and legs light brown, cerci brown. Head with X-shaped pattern connecting ocelli, forward of which is an inverted bell-shaped light pattern; 2

light round spots inside eyes and mesal light bell-shaped mark from between lateral ocelli to occiput; postocular spinules and sparse sinuate row of indistinct occipital spinules present (Fig. 5 A). Laciniae triangular, bidentate with inner marginal setae only along apical

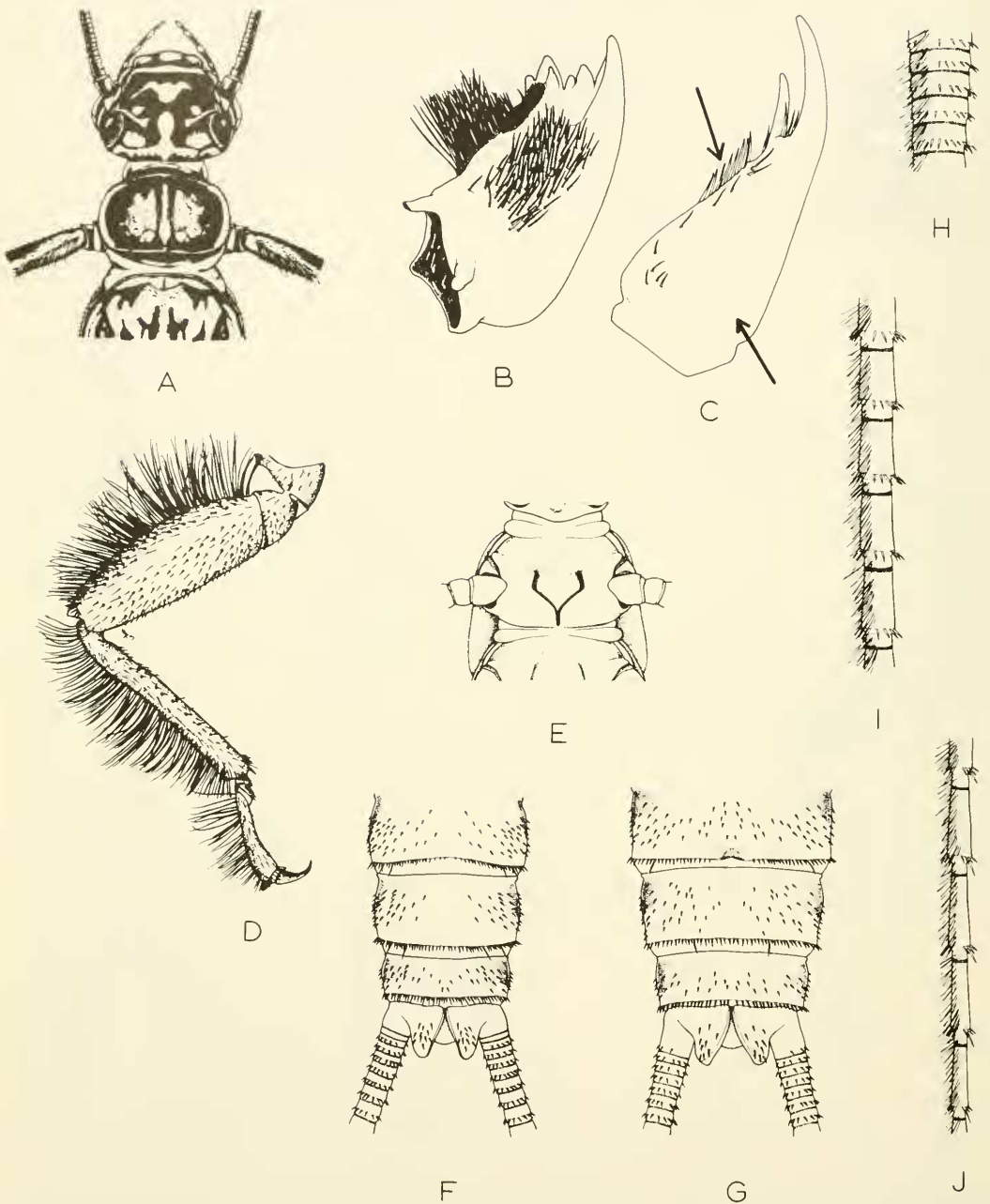


Fig. 5. Nymphal characters of *Diura knowltoni*: A, head, pronotum pattern; B, left mandible (ventral); C, left lacinia (ventral); D, right front leg (anterior); E, mesosternal Y-pattern; F, ♂ ventral abdomen; G, ♀ ventral abdomen; H, I, J, basal, middle, and apical cercal segments (dorsal).

half; full row of about 10 submarginal setae and 2 or 3 axillary setae; terminal tooth about 0.3 total outer lacinial length, and sub-apical tooth 0.5 length of terminal tooth (Fig.

5 C). Left mandible without deep cleft, serrations of teeth or patch of median ventral setae; row of acanthae along inner base of dorsal teeth. Gills absent. Pronotum with

light, narrow lateral margins and mesal stripe; with submarginal brown band and interior reticulate dark lines on a light background; short spinules on anterior, posterior margins, few or none laterally (Fig. 5 A). Wingpads with mesal mushroom-shaped light pattern and short, stout setae laterally (Fig. 5 A). Y-arms of mesosternum reach posterior corners of furcal pits (Fig. 5 E). Femora with short setae, a longitudinal dark marking apically and fringe of golden, silky hairs (Fig. 5 D). Tibiae and tarsi with golden, silky hair fringe (Fig. 5 D). Abdominal terga brown with pair of large, light mesal spots giving overall appearance of a wide, central, light longitudinal abdominal band; each segment with apical setal row and more than 50 sharp intercalary spinules. Cercal segments with whorl of short setae less than 0.5 length of segments; complete dorsal fringe of short, golden, silky hairs (Fig. 5 H–J). Posterior setal row of male 8th abdominal sternum little interrupted (Fig. 5 F); a wide mesal interruption of setae, and a shallow notch on female 8th abdominal sternum (Fig. 5 G).

NYMPH BIOLOGY.—Relatively poorly known for the North American *D. knowltoni*. It is found in small streams and larger rivers with stony substrata at 7,220–10,300 ft elevation in Gunnison River drainage, Colorado (Knight 1965, Knight and Gaufin 1966). Emergence is in Apr.–Jun. in Pacific Northwest and Rocky Mountains (Jewett 1959, Baumann et al. 1977). Sheldon (1972) found *D. knowltoni* only above 1810 m in Sagehen Crk and above 1900 m in the Little Truckee River. Nymphs were strict carnivores, with major prey items split between Diptera and Trichoptera larvae. Small nymphs were first collected in Aug. and growth was continuous through fall and winter until emergence in May and Jun. There are no reports on the biology of *D. bicaudata* and *D. nanseni* nymphs in North America. Both species have univoltine cycles in Sweden, with rapid growth in autumn (Aug.–Oct.) and spring (Apr.–Jun.), slowed growth in winter (Oct.–Mar.), and emergence in Jun.–Jul., and both are carnivorous, feeding primarily on mayfly nymphs and diptera larvae (Brinck 1949).

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.—(1) *Diura bicaudata* — ALAS, NWT,

YUK, (2) *Diura knowltoni* (Frison) — ALB, BC, COL, ID, MONT, NEV, NM, OR, SASK, UT, WYO, YUK, (3) *D. nanseni* (Kempny) — NH, QUE.

Frisonia Ricker

TYPE SPECIES.—*Frisonia picticeps* (Hanson).

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.—Ricker (1943; mandible, maxilla), Ricker (1959, written description in key for subgenus *Frisonia* was erroneously given under subgenus *Skwala*).

NYMPH DESCRIPTION.—(Figs. 6 A–L) Body brown with dark brown markings; legs light brown, antennae and cerci brown. Dark clothing hairs lying flat over whole dorsal surface and legs. Head mostly brown with faint M-pattern anterior to median ocellus and 2 light spots posterior to M (Fig. 6 A, L); sinuate row of occipital spinules, interrupted mesally. Bushy band of long, white shaggy hairs across back of head between eyes, and mesally from prothorax to tip of abdomen (Fig. 6 L). Laciniae triangular, bidentate, and strongly curved, with full row of very stout marginal and submarginal setae and 3 axillary setae; row of 10–12 stout setae extending up onto ventral basal portion of terminal tooth; terminal tooth about 0.3 total outer lacinial length and subapical tooth about 0.6 length of terminal tooth (Fig. 6 C). Left mandible deeply cleft with prominent serrations of teeth; without median ventral setal patch; row of acanthae along base of dorsal tooth (Fig. 6 B). Submental gills prominent, about 2 times their basal diameter (Fig. 6 E). Pronotum brown with light mesal longitudinal band, light reticulate markings and short marginal spinules (Fig. 6 A). Wingpads with reticulate pattern and short marginal spinules (Fig. 6 A). Y-arms of meso-sternum reach or nearly reach anterior corners of furcal pits (Fig. 6 F). Femora with spinules or stout setae restricted to narrow band adjacent to dorsal fringe; dense fringe of long, silky, white hairs (Fig. 6 D). Tibiae with few scattered spinules and dense fringe of long silky hairs, and tarsi with row of silky hairs (Fig. 6 D). Abdominal segments dark brown with short apical setal row and few scattered, very short, blunt intercalary spinules (Fig. 6 L).

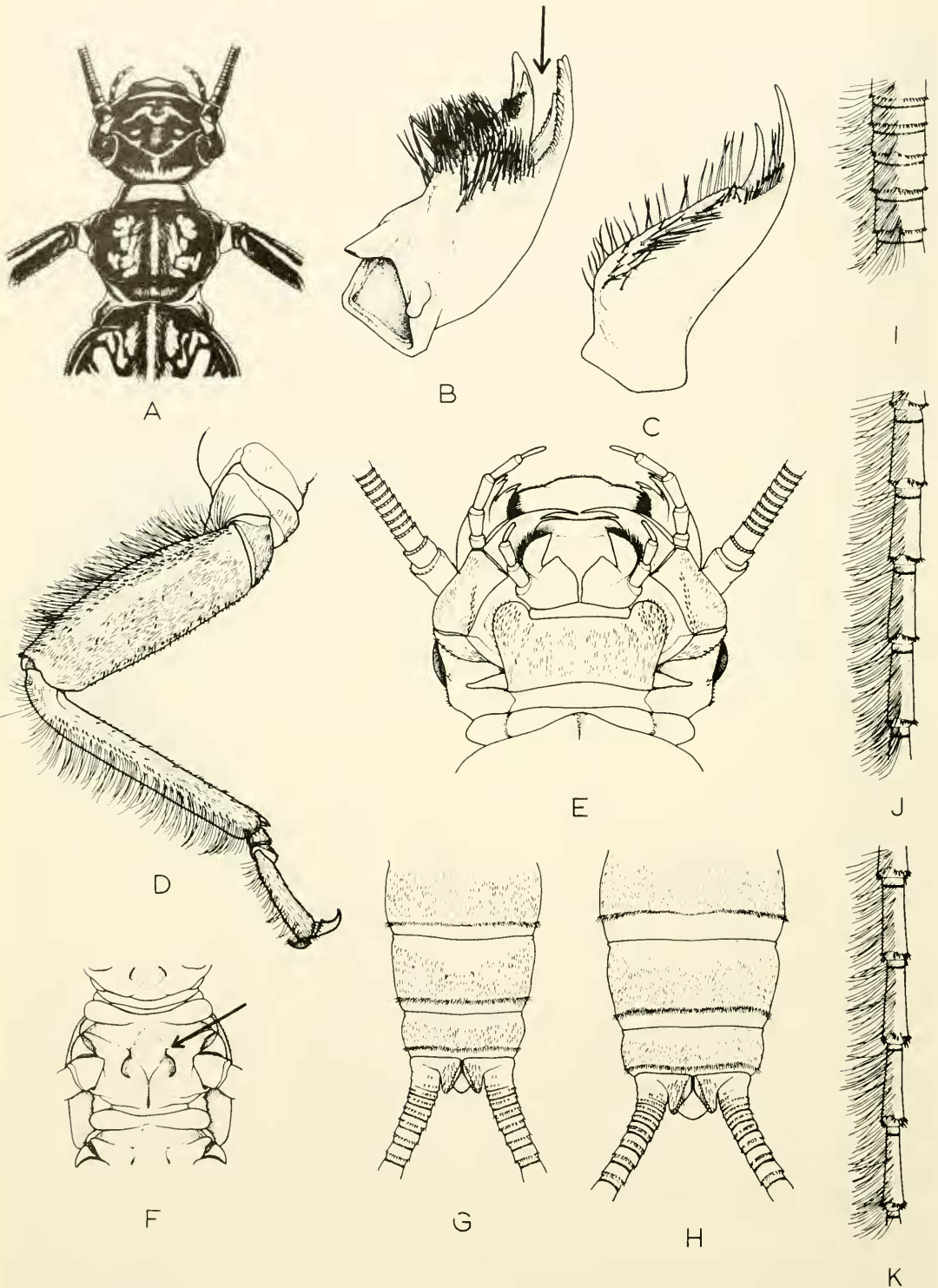


Fig. 6. Nymphal characters of *Frisonia pictipes*: A, head, pronotum pattern; B, left mandible (ventral); C, left lacinia (ventral); D, right front leg (anterior); E, submental gills; F, mesosternal Y-pattern; G, ♂ ventral abdomen; H, ♀ ventral abdomen; I, J, K, basal, middle, and apical cercal segments (dorsal).

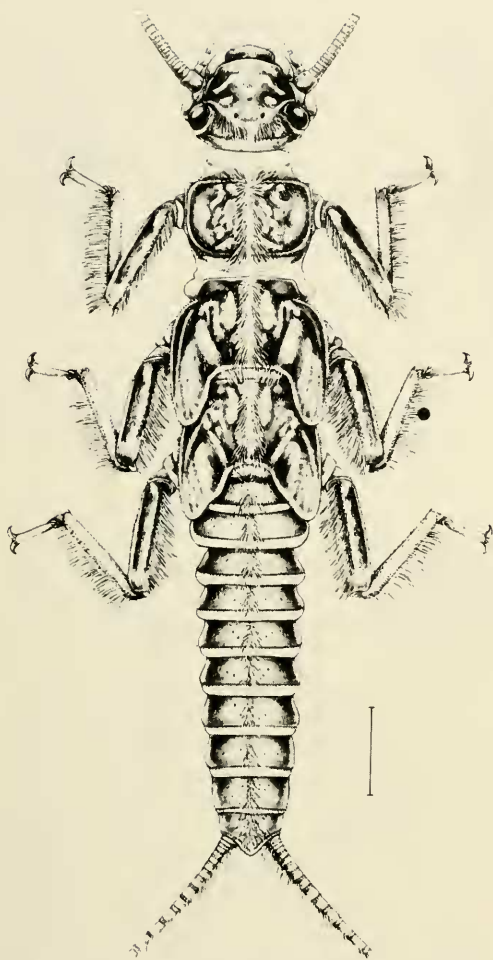


Fig. 6L. *Frisionia picticeps*: nymph habitus; scale line = 2 mm.

Cercal segments with whorl of short apical spinules, and cerci with full dorsal fringe of silky, white hairs (Figs. 6 I-K). Posterior setal row of male and female 8th abdominal segments interrupted (Figs. 6 G-H).

NYMPH BIOLOGY.—Relatively poorly known. Sheldon (1972) found *F. picticeps* to be relatively common in riffle samples taken above 1810 m in Sagehen Creek. Small nymphs were collected in Aug. and a continuous growth pattern was exhibited until emergence in May and Jun. Nymphs fed primarily on Diptera larvae, but considerable plant material was ingested by nymphs feeding on smaller larvae.

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.—Monospecific genus; *F. picticeps* — BC, CAL, NEV, ORE, WN.

Helopicus Ricker

TYPE SPECIES.—*Helopicus nalatus* (Frison).

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.—(1) *H. bogaloosa* — Stark and Ray (1983; head/pronotum, lacinia, mandibles with acanthae, detail of occiput) (2) *H. nalatus* — Frison (1942; habitus, mandibles, labium, maxilla), Ricker (1952), Stark and Ray (1983; head/pronotum, lacinia, mandibles, labrum), (3) *H. subvarians* — Ricker (1952; habitus, maxilla).

NYMPH DESCRIPTION.—(*H. nalatus*) (Figs. 7 A-K). Body and legs yellow with brown markings; antennae and cerci yellow. Head with transverse brown band between antennae, enclosing anterior ocellus; brown spot between lateral ocelli, and irregular narrow brown bands behind arms of ecdysial suture; complete, sinuate band of stout occipital spinules 2-3 wide (Fig. 7 A). Laciniae triangular, bidentate, with row of 20-22 marginal setae, 8-10 submarginal setae, and 3 or 4 axillary setae; terminal tooth about 0.35 total outer lacinial length and subapical tooth about 0.5 length of terminal tooth (Fig. 7 C). Right mandible without deep cleft, and with serrations on ventral 2 teeth; no distinctly separated median ventral setal patch; band of acanthae from base of tooth 3 to marginal setae (Fig. 7 B). Prominent submental gills, projecting portion about 3 times basal diameter (Fig. 7 E). Pronotum yellow with marginal brown band, narrow, dark mesal longitudinal band and irregular lateral, dark reticulate markings; complete marginal row of short spinules (Fig. 7 A). Y-arms of mesosternum meet posterior corners of furcal pits (Fig. 7 F). Wingpads with irregular reticulate brown markings; spinules on all margins (Fig. 7 A). Femora with posterodorsal, longitudinal brown band, apical transverse brown band, numerous stout dorsal spinules, and dense fringe of silky, yellow hairs (Fig. 7 D); tibiae with spinules, and tibiae and tarsi with dorsal fringe of silky, yellow hairs (Fig. 7 D). Abdominal terga 1-9 with anterior transverse brown band and thin brown apical margin; segment 10 with median transverse band; numerous stout intercalary spinules (> 100) and posterior fringe of setae. Cercal segments with apical whorl of short setae and complete dorsal fringe of silky, yellow hairs (Figs.

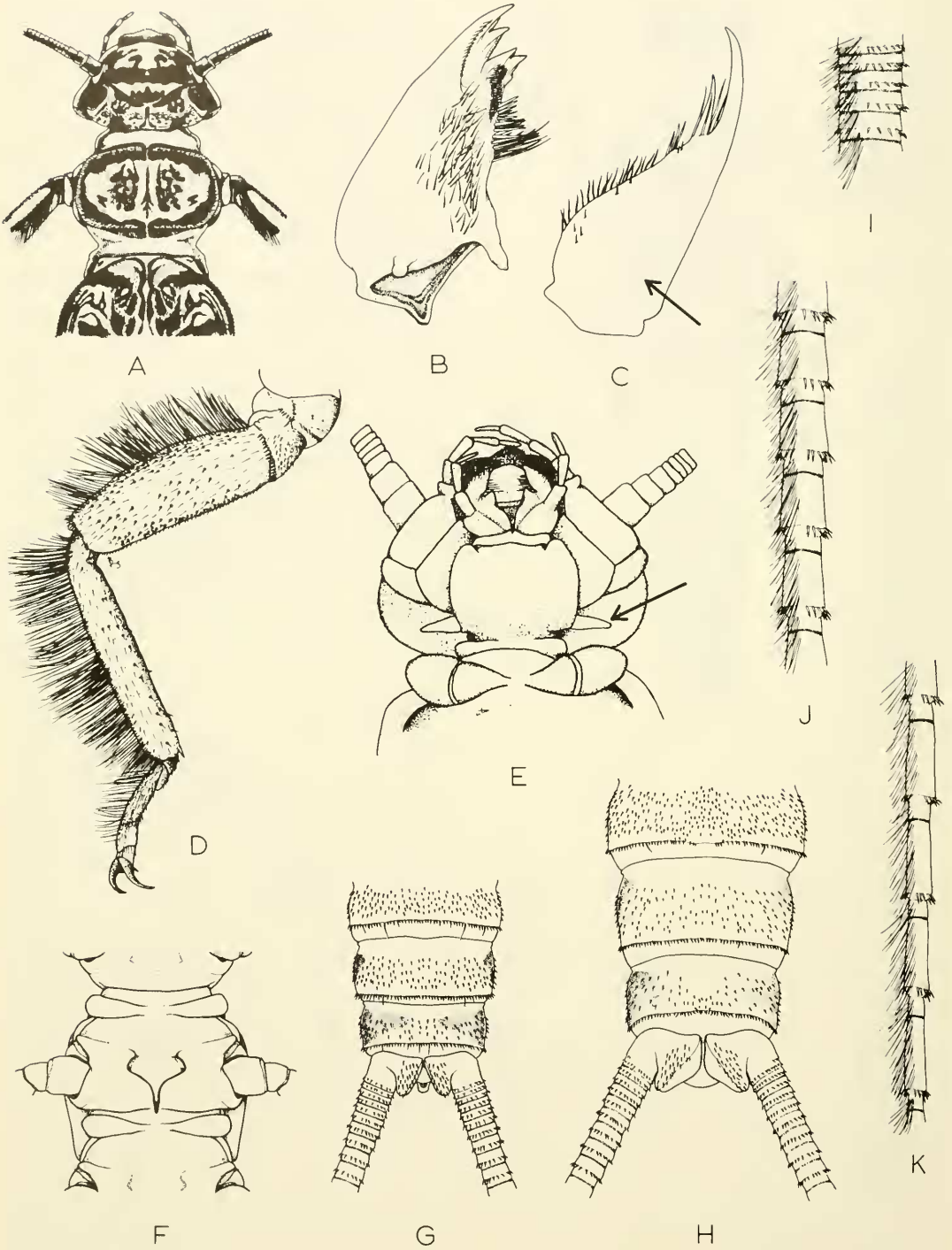


Fig. 7. Nymphal characters of *Helopicus nalatus*: A, head, pronotum pattern; B, right mandible (ventral); C, left lacinia (ventral); D, right front leg (anterior); E, submental gills; F, mesosternal Y-pattern; G, ♂ ventral abdomen; H, ♀ ventral abdomen; I, J, K, basal, middle, and apical cercal segments (dorsal).

7 I-K). Posterior setal row of male 8th abdominal sternum uninterrupted mesally (Fig. 7 G); setal row of female interrupted mesally (Fig. 7 H).

NYMPH BIOLOGY.— Poorly known, *H. natalus* collected as nymphs from late Jan.–May (Frison 1942), primarily in debris and leaf packs in Arkansas (J. Feminella and K. Stewart, unpubl. data).

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.— (1) *Helopicus bogaloosa* Stark & Ray — FLA, GA, LA, MS, (2) *H. natalus* — ARK, IND, KAN, MICH, MO, OK, (3) *H. subvarians* (Banks) — CONN, FLA, MAINE, NC, ONT, PA, QUE, SC, TN, VA, WV.

Hydroperla Frison

TYPE SPECIES.— *Hydroperla crosbyi* (Needham & Claassen).

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.— (1) *H. crosbyi* — Frison (1935; labrum, mandible, maxilla, labium, mentum, submentum, habitus), Ross and Frison (1937), Ricker (1952), Stewart et al. (1976; mesosternal Y-arms), Oberndorfer and Stewart (1977; 1st instar habitus, mouthparts), Ray and Stark (1981; mandible, lacinia, labrum), Shepard and Stewart (1982; gills), (2) *H. fugitans* — Frison (1935; habitus, labrum, mandible, maxilla, labium, mentum, submentum), Ray and Stark (1981; labrum, mandible, lacinia), (3) *H. phormidia* — Ray and Stark (1981; habitus, labrum, mandible, lacinia).

NYMPH DESCRIPTION.— (*H. crosbyi*) (Figs. 8 A–K). Body and legs yellow with brown markings; antennae and cerci yellow. Head with wide M-band between antennal bases, enclosing 3 yellow spots; yellow M-band anterior to median ocellus and brown transverse band anterior to it; 2 irregular brown marks behind eyes, enclosing sinuate band of spinules 2–3 wide; occipital spinule band interrupted by wide mesal space (Fig. 8 A). Laciniae triangular, bidentate, with row of 16–20 marginal setae, 4–6 submarginal setae, 2 axillary setae and well-developed median ventral patch of 10–12 setae; terminal tooth about 0.25 total outer lacinial length and subapical tooth about 0.5 length of terminal tooth (Fig. 8 C). Left mandible without deep cleft, distinct serrations of teeth or median ventral setal patch; band of acanthae from

base of dorsal teeth to marginal setae (Fig. 8 B). Prominent submental gills, projecting portion about 2.0–2.5 times their basal diameter (Fig. 8 E). Pronotum encircled with wide brown band except for narrow light lateral margins; complete marginal row of short setae (Fig. 8 A). Y-arms of mesosternum meet posterior corners of furcal pits (Fig. 8 F). Wingpads with anterior brown markings, with M-shaped mesal mark, and flat posterior U-mark; short setae on all margins (Fig. 8 A). Femora with median dorsal, longitudinal, dark bar, numerous short spinules and dorsal fringe of silky, yellow hairs; tibiae/tarsi with silky, yellow hair fringe (Fig. 8 D). Abdominal terga with anterior, transverse brown band and posterior brown margin; short posterior setal fringe and numerous (> 50) intercalary spinules. Cercal segments with apical whorl of short setae and complete dorsal fringe of silky, yellow hairs (Figs. 8 I–K). Posterior setal row of male 8th abdominal sternum uninterrupted mesally (Fig. 8 G); 8th sternal setal row of female interrupted mesally (Fig. 8 H).

NYMPH BIOLOGY.— Well known for *H. crosbyi*. Early instars appear in late Oct. in Texas, after an approximate 7-month egg diapause. They grow rapidly through the winter and emerge in Feb.–Mar. Male and female nymphs have an estimated 12 and 14 instars, respectively. Nymphs are carnivorous, feeding primarily on Chironomidae and Simuliidae larvae, and mayfly nymphs (Oberndorfer and Stewart 1977). Found in permanent and intermittent streams throughout the Mississippi Valley, southward to Arkansas, Oklahoma, and Texas, in debris, leaf packs and cobble-gravel riffle substrate (Frison 1935, Szczytko and Stewart 1977). Brief notes were given by Frison (1935) on the biology of *H. fugitans* (as *H. harti*) that indicated its life cycle and food habits are similar to *H. crosbyi*. *H. phormidia* occurs in brown-water coastal rivers in Northwest Florida, in leaf packs associated with blue-green algae; it feeds on Chironomidae and Simuliidae larvae and emerges in Mar.–Apr., based on field collections of exuviae, the single field-collected adult male, and laboratory rearings of a male and female (Ray & Stark 1981).

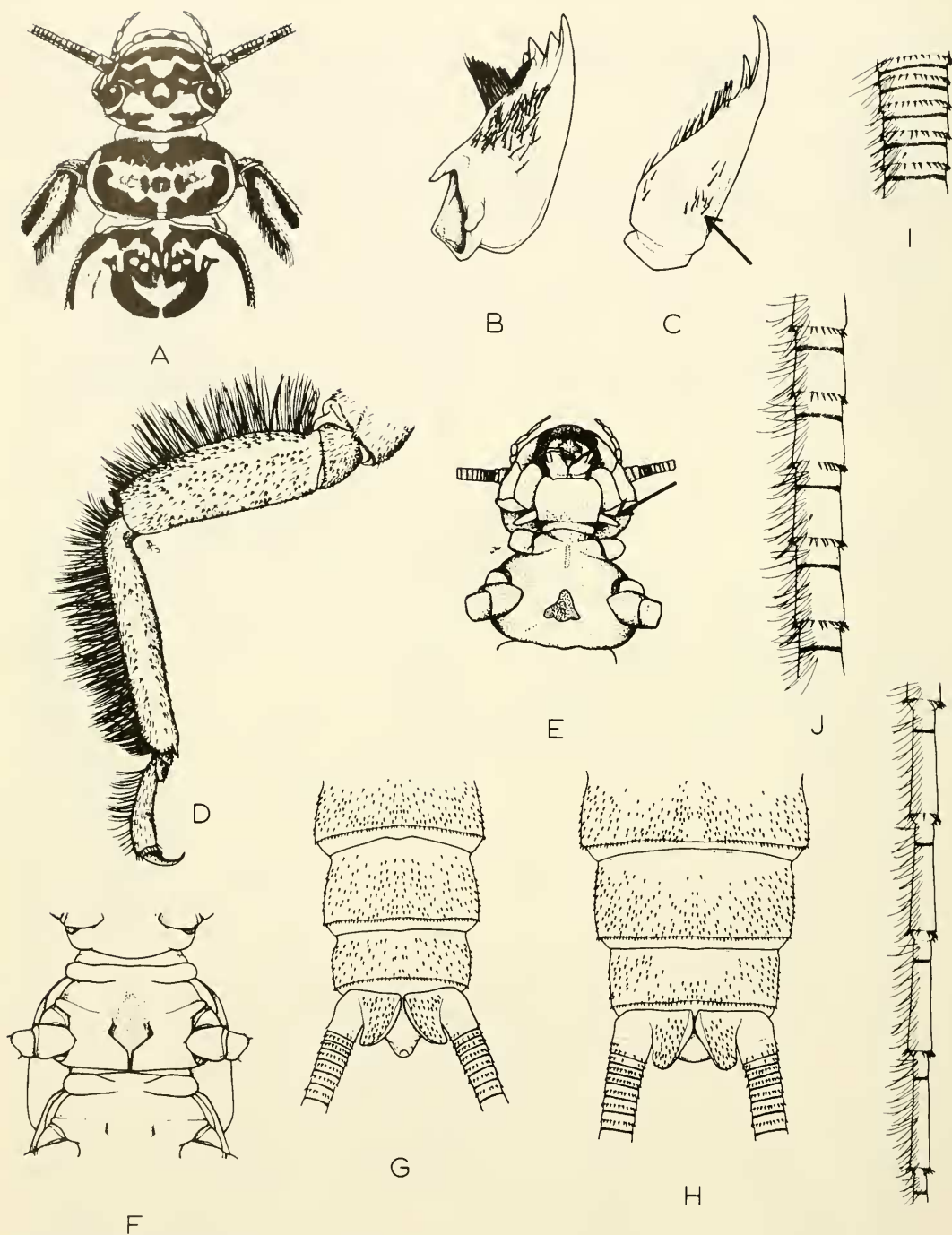


Fig. 8. Nymphal characters of *Hydroperla crosbyi*: A, head, pronotum pattern; B, left mandible (ventral); C, left lacinia (ventral); D, right front leg (anterior); E, submental gills; F, mesosternal Y-pattern; G, ♂ ventral abdomen; H, ♀ ventral abdomen; I, J, K, basal, middle, and apical cercal segments (dorsal).

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.—(1) *Hydroperla crosbyi* — ARK, ILL, IND, KAN, TN, TX, (3) *H. phormidia* Ray & Stark — FLA. (2) *H. fugitans* (Needham & Claassen) — ARK, ILL, IND, KAN, TN, TX, (3) *H. phormidia* Ray & Stark — FLA.

Isogenoides Klapálek

TYPE SPECIES.—*Isogenoides frontalis* (Newman).

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.—(1) *I. colubrinus* — (possibly Claassen 1931), (2) *I. doratus* — Frison (1942; habitus, mandible, maxilla, labium), (3) *I. elongatus* — Ricker (1952; mandible), Baumann et al. (1977; lacinia), (4) *I. frontalis* — Frison (1942; habitus, mandibles, maxilla, labium), Hilsenhoff and Billmyer (1973; lacinia), (5) *I. hansonii* — Ricker (1952; habitus, mandibles, labium), (6) *I. krumholzi* — none, (7) *I. olivaceus* — Frison (1942; habitus, mandibles, maxilla, labium), Hilsenhoff and Billmyer (1973; lacinia), (8) *I. varians* — Ross and Frison (1937; habitus), (9) *I. zionensis* — Ricker (1952), Baumann (1973; habitus, maxillae, mandibles), Baumann et al. (1977; labrum, labium with gills, maxilla, mandible, mesosternal ridge pattern), Shepard and Stewart (1982; gills—text and illustrations of *frontalis* are actually *zionensis*).

NYMPH DESCRIPTION.—(*I. zionensis*). Body yellow with light brown markings; antennae, legs yellow, cerci brown; thin rows of long, light, silky hairs along middorsal line of thorax and abdomen. Head with yellow M-mark forward of anterior ocellus; ocellar triangle enclosing a brown spot; occiput with large yellow spots, enclosed by brown, well-developed row of occipital spinules, interrupted mesally (Fig. 9 A). Laciniae triangular, bidentate with a distinct knob below subapical tooth; complete row marginal setae and scattered submarginal setae in 3 groups of 2 or 3 setae each; 2 or 3 axillary setae; terminal tooth about 0.35 total outer lacinial length, and subapical tooth about 0.5 length of terminal tooth (Fig. 9 C). Left mandible without deep cleft or median ventral patch of setae; distinct serrations on ventral tooth; row of acanthae at base of dorsal teeth (Fig. 9 B). Prominent submental gills, projecting portion about 3 times their basal diameter (Fig. 9 E). Pronotum with faint reticulate light brown pattern, a narrow anterior transverse dark band, posterior brown margin and light lateral margins; anterior and posterior marginal row of short setae, sometimes with 2 or 3 longer setae on corners. Y-arms of mesosternum reach posterior corners of furcal pits; a

distinctive median longitudinal ridge connecting fork of Y with a transverse ridge (Fig. 9 F). Meso-metanota with pairs of large round anteromesal light spots and faint pattern; stout spinules on anterior margins, and scattered in darker pigmented areas. Legs with short, stout setae and dense dorsal fringe of silky, yellow hairs (Fig. 9 D). Abdominal terga light brown, somewhat darker anteriorly, with more than 100 stout intercalary spinules and posterior row of short, stout setae. Posterior setal row of male 8th abdominal sternum uninterrupted mesally (Fig. 9 G); setal row of female 8th sternum interrupted mesally, and often notched (Fig. 9 H). Cercal segments with apical whorl of short, stout setae; cerci with complete dorsal fringe of silky, yellow hairs (Figs. 9 I-K).

NYMPH BIOLOGY.—Poorly known except brief notes for the eastern *I. frontalis* and western *I. zionensis*. We have found *I. zionensis* nymphs in small, clear, rock-bottomed creeks and large silty rivers in Colorado and Utah; they are often the only large perlodids in lower reaches of rivers (Baumann et al. 1977). Mature *I. zionensis* nymphs are found in May in Colorado. Adults have been collected in late May in Utah (Baumann 1973) and Jun. in the Northwest Territories (Ricker 1955). Baumann et al. (1977) gave emergence times for *I. colubrinus* and *I. elongatus* as Mar.-Aug. and May-Jun., respectively. Hilsenhoff and Billmyer (1973) and Dossdall and Lemkuhl (1979) reported univoltine life cycles for *I. frontalis* in Wisconsin and Saskatchewan, based on collections of uniformly large nymphs in May, emergence in May-Jun. and appearance of early instars in early Aug. Harper and Pilon (1975) reported emergence in Jul.-Aug. in northern Quebec, and Shapas and Hilsenhoff (1976) found larval Chironomidae and other Diptera in the guts of nymphs.

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.—(1) *Isogenoides colubrinus* (Hagen) — ALAS, ALB, BC, COL, ID, MANIT, MONT, NWT, SASK, UT, WYO, YUK, (2) *I. doratus* (Frison) — IOW, MICH, PA, QUE, (3) *I. elongatus* (Hagen) — ALB, ARIZ, BC, COL, ID, MONT, NM, UT, WN, WYO, (4) *I. frontalis* — LAB, MANIT, MICH, MINN, NY, QUE, SASK, WISC, (5) *I. hansonii* (Ricker) — CONN, MASS, MD, NEW BR, NC, NS,

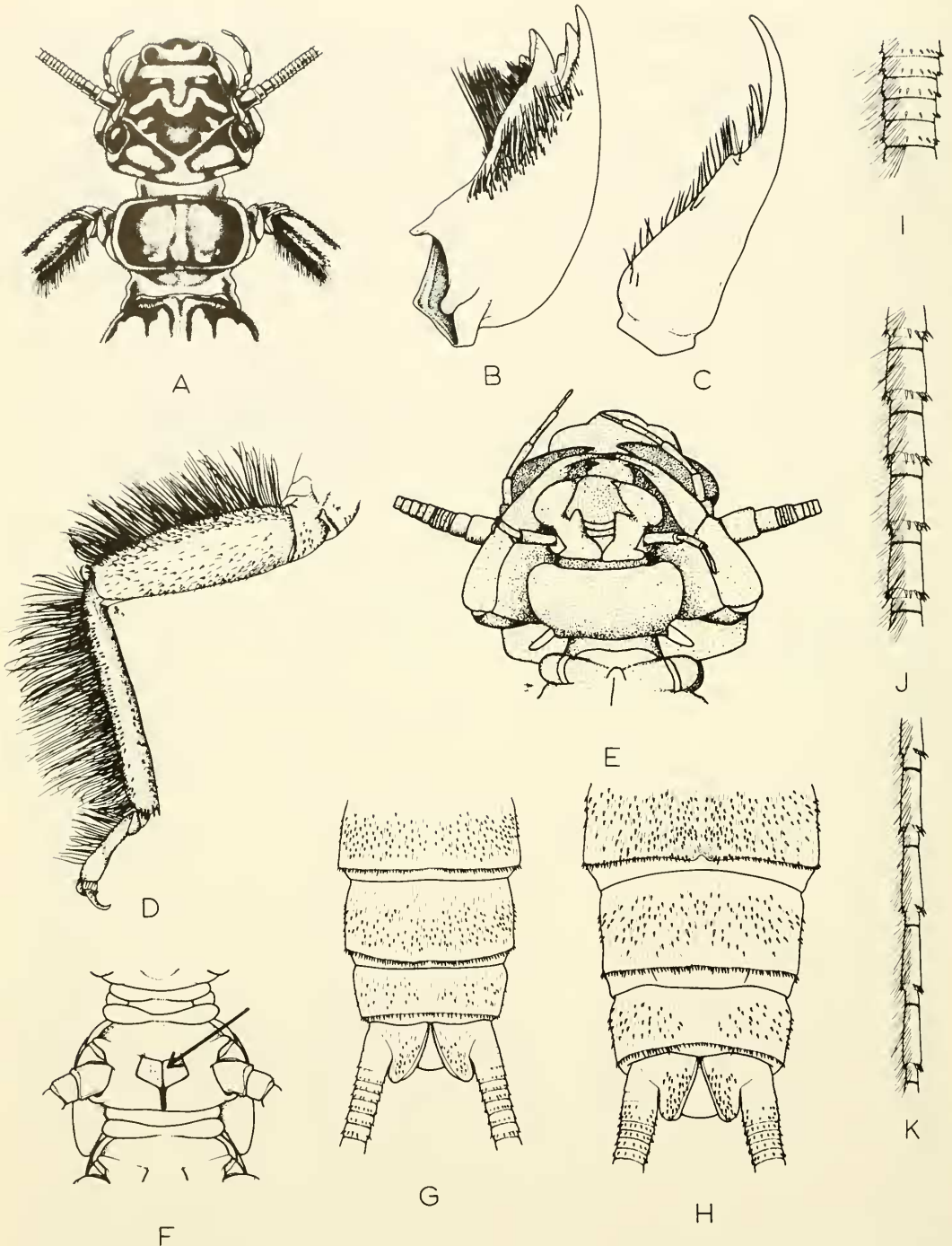


Fig. 9. Nymphal characters of *Isogenoides zionensis*: A, head, pronotum pattern; B, left mandible (ventral); C, left lacinia (ventral); D, right front leg (anterior); E, submental gills; F, mesosternal Y-pattern; G, ♂ ventral abdomen; H, ♀ ventral abdomen; I, J, K, basal, middle, and apical cercal segments (dorsal).

NY, PA, QUE, VA, WV, (6) *I. krumholzi* (Ricker) — MICH, MINN, (7) *I. olivaceus* (Walker) — MICH, MINN, ONT, QUE, WISC, (8) *I. varians* (Walsh) — ILL, IND, MICH, MS, SC, TN, (9) *I. zionensis* — ALAS, COL, NM, NWT, UT.

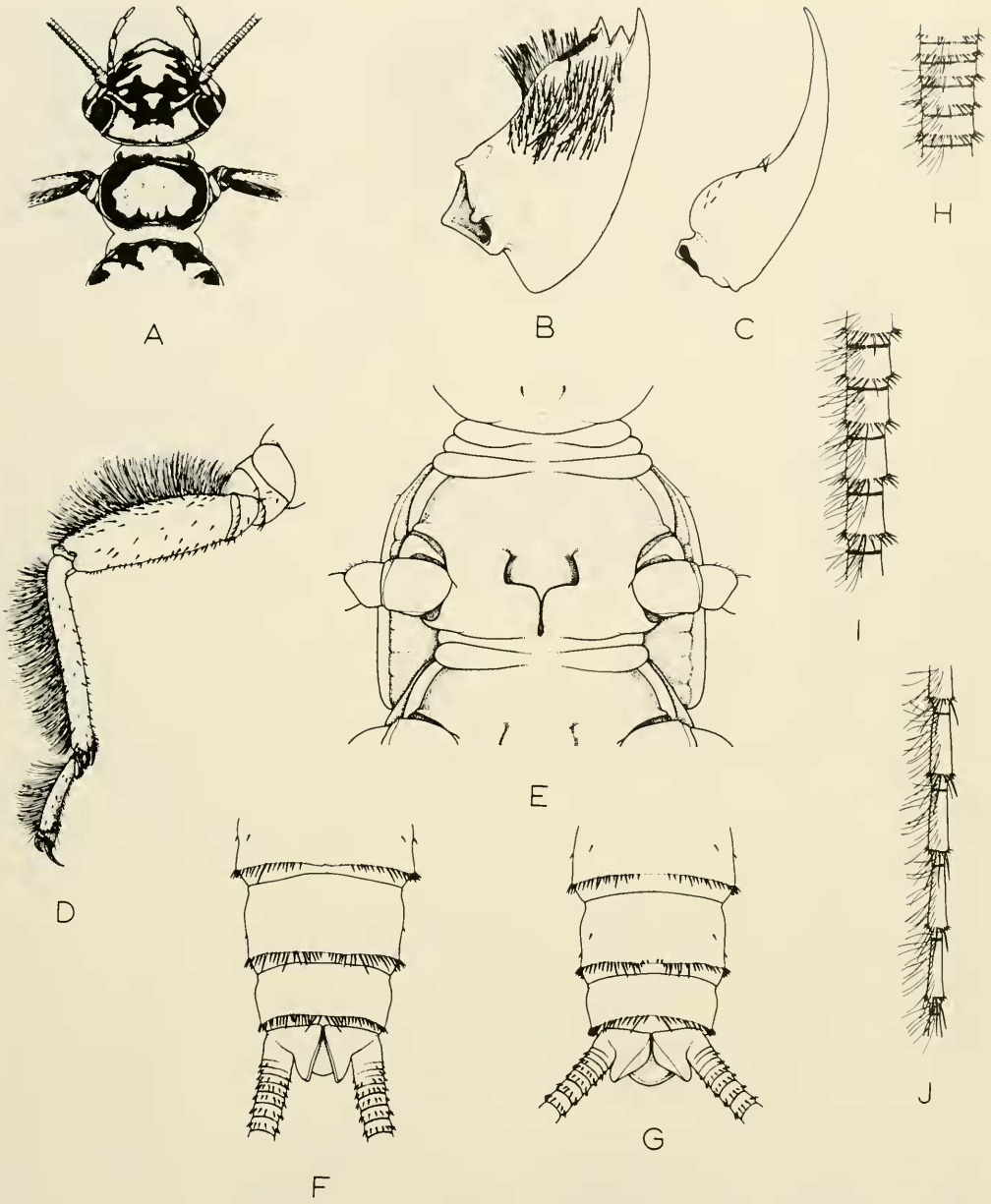


Fig. 10. Nymphal characters of *Kogotus nonus*: A, head, pronotum pattern; B, left mandible (ventral); C, left lacinia (ventral); D, right front leg (anterior); E, mesosternal Y-pattern; F, ♂ ventral abdomen; G, ♀ ventral abdomen; H, I, J, basal, middle, and apical cercal segments (dorsal).

Kogotus Ricker

TYPE SPECIES.—*Kogotus nonus* (Needham & Claassen).

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.—(1) *K. alameda* — none, (2) *K. modestus* — Frison (1942; habitus, mandibles, maxilla, labium), (3) *K. nonus* — Ricker

(1952), Baumann et al. (1977); no previous nymphal illustrations.

NYMPH DESCRIPTION.—(*K. nonus*) (Figs. 10 A-J). Body brown with dark brown markings; antennae, legs, cerci brown. Head with light M-pattern anterior to darker M, between antennae; light spot in ocellular triangle and 2 small light spots outside lateral

ocelli; occiput light, without spinule row (Fig. 10 A). Laciniae unidentate with 6–8 submarginal setae scattered along basal half (Fig. 10 C). Left mandible without deep cleft, serrations of teeth or median patch of ventral setae; row of acanthae along base of dorsal teeth (Fig. 10 B). Gills absent. Pronotum light, encircled with brown band, except light lateral margins; a few tiny marginal spinules, but mostly glabrous (Fig. 10 A). Y-arms of meso-sternum meet posterior corners of furcal pits; no transverse anterior suture connecting furcal pits (Fig. 10 E) as in *Rickera scripta* (Fig. 19 E). Meso-metanota with indistinct markings mostly glabrous (Fig. 10 A). Legs brown with stout, sharp setae and dorsal fringe of silky, golden hairs (Fig. 10 D). Abdominal terga with posterior fringe of stout, sharp setae, longest mesally; segments 1–5, with fewer than 5 intercalary spinules, if present, and segments 6–10, with 10 or fewer intercalary spinules. Both male and female 8th abdominal sternae with meso-posterior interruption of posterior setal row (Figs. 10 F, G). Cercal segments with apical whorl of short, stout setae, and cerci with dorsal fringe of silky, golden hairs (Figs. 10 H–J).

NYMPH BIOLOGY.— Poorly known for *K. nonus* except that nymphs are rare in some intensively studied streams (Sheldon and Jewett 1967, Kerst and Anderson 1974) and emerge Apr.–Sep. (Jewett 1959, Sheldon and Jewett 1967, Gaufin et al. 1972, Baumann et al. 1977). *K. modestus* (Banks) is univoltine in Colorado; final instars are present through Aug. and feed primarily on Chironomidae and mayflies (Allan 1982).

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.— (1) *Kogotus alameda* (Needham & Claassen) — CAL, (2) *K. modestus* (Banks) — BC, COL, ID, MONT, NM, UT, WYO, (3) *K. nonus* — BC, CAL, ID, MONT, ORE, WN, WYO.

Malirekus Ricker

TYPE SPECIES.— *Malirekus hastatus* (Banks).

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.— Claassen (1931; labrum, mandibles, maxillae, labium, leg, habitus), Frison (1942),

Ricker (1952), Ricker (1959; submental gills, mesosternal ridge), Shepard and Stewart (1983; gills).

NYMPH DESCRIPTION.— (Figs. 11 A–K). Body brown with dark brown markings; antennae, legs, cerci light brown. Head mostly brown with light M-mark forward of anterior ocellus; two light, ovate spots lateral to ocellular triangle, and light interocellar spot; two large ovate occipital spots, broken by reticulate brown lines and bordered behind by row of short, blunt spinules (Fig. 11 A). Laciniae bidentate, with clump of about 8 stout marginal setae located on slight knob below subapical tooth, and 4–5 scattered setae along middle inner margin; 2 or 3 scattered, short, stout submarginal setae, 2–3 axillary setae and dense median ventral patch of over 60 black clothing setae; terminal tooth about 0.35 total outer lacinial length and subapical tooth about 0.5 length of terminal tooth (Fig. 11 C). Left mandible without deep cleft, serrations of teeth or median ventral setal patch (Fig. 11 B). Projecting portion of submental gills about 2 times their basal diameter (Fig. 11 E). Pronotum mostly light with reticulate dark pattern and dark clothing hairs; margins without setae (Fig. 11 A). Y-arms of mesosternum meet posterior corners or furcal pits (Fig. 11 F). Meso-metanota with anterior and posterior mesal triangulate light spots, and pair of central triangulate spots. Femora with 2 longitudinal narrow brown bands, irregular sparse row of short spinules along base of fringe hairs, and very sparse intercalary dorsal spinules. Femora and tibiae with dense fringe of white, silky hairs (Fig. 11 D). Abdominal terga brown with faint mesal, longitudinal, darker band and short, dark clothing hairs; fewer than 10 short intercalary spinules, and posterior fringe of very short setae. Cercal segments with apical whorl of short setae and dorsal fringe of silky, white hairs (Figs. 11 I–K). Posterior setal row of male 8th abdominal sternum with narrow mesal interruption (Fig. 11 G); 8th sternal setal row of female with wide mesal gap associated with developing subgenital plate (Fig. 11 H).

NYMPH BIOLOGY.— Relatively poorly known, with only general reference. Abundant in small upland spring brooks (Claassen

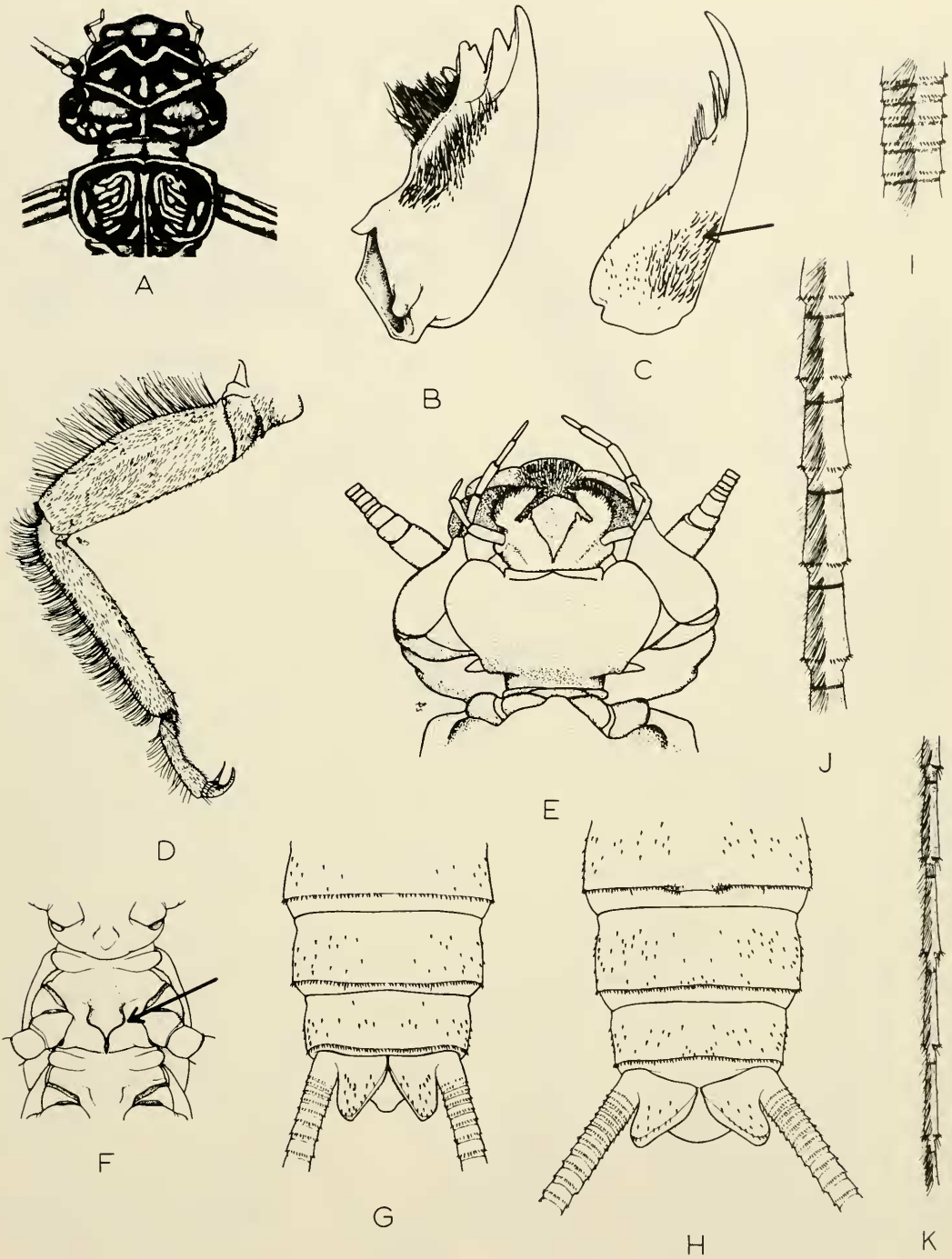


Fig. 11. Nymphal characters of *Malirekus hastatus*: A, head, pronotum pattern; B, left mandible (ventral); C, left lacinia (ventral); D, right front leg (anterior); E, submental gills; F, mesosternal Y-pattern; G, ♂ ventral abdomen; H, ♀ ventral abdomen; I, J, K, basal, middle, and apical cercal segments (dorsal).

1931), small Appalachian streams (Ricker 1952), 1st to 3rd order streams in ridge and valley, and Blue Ridge provinces of Virginia

(Kondratieff and Voshell 1982). Adults active Apr.-early Jun. (Kondratieff and Voshell 1982).

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.— Monospecific genus; *M. hastatus* — GA, KY, MAINE, NC, NY, QUE, SC, TN, VA, WV.

Megarcys Klapálek

TYPE SPECIES.— *Megarcys ochracea* Klapálek.

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.— Only nymphs of *M. signata* have been described—Claassen (1931), Ricker (1943; habitus, labium, maxilla), Gaufin (1966; mesosternum), Cather & Gaufin (1975), Baumann et al. (1977; mesosternum).

NYMPH DESCRIPTION.— (*M. signata*) (Figs. 12 A–K). Body light brown with dark markings, and covered with short, dark clothing hairs; with mesal, longitudinal band of sparse, erect, silky, white hairs on thorax and abdomen and behind arms of ecdysial suture on head. Head mostly dark with light M-pattern forward of anterior ocellus, small light round spots lateral to ocellar triangle, light interocellar area, and nearly complete mesal longitudinal light band; ovate light occipital spots inside eyes, broken by reticulate brown lines and bordered behind by row of spinules (Fig. 12 A). Laciniae bidentate, with complete row of about 20 marginal setae along apical $\frac{2}{3}$ of inner margin, a row of about 15 submarginal setae, 2 or 3 axillary setae, and no median ventral patch of setae; terminal tooth about 0.4 total outer lacinial length and subapical tooth about 0.5 length of terminal tooth (Fig. 12 B). Left mandible without deep cleft; ventral tooth with prominent serrations, and median ventral patch of 4 setae (Fig. 12 C). Long submental gills, and a pair of curved simple gills located anterior supra-coxal, anterior thoracic₂ and anterior thoracic₃ (Fig. 12 F). Pronotum mostly dark with reticulate light markings; darker areas covered by dark clothing hairs; a few short marginal spinules, but marginal setae absent (Fig. 12 A). Y-arms of mesosternum meet anterior corners of furcal pits (Fig. 12 F). Meso-metanaota with light vase-shaped mesoposterior marking and pair of irregular ovate light spots; covered with dark clothing hairs. Dorsal surface of femora with dark clothing hairs, except on a mesal longitudinal band, and row of spinules at base of fringe hairs;

femora and tibiae with dorsal fringe of silky, white hairs (Fig. 12 D). Abdominal terga brown with dense intercalary spinules and a posterior fringe of short spinules; faint pairs of small, light spots mesally and laterally. Cercal segments with apical whorl of short setae, and dorsal fringe of silky, white hairs (Figs. 12 I–K). Posterior setal row of male 8th abdominal sternum with mesal interruption (Fig. 12 G); posteromedian portion of female 8th sternum modified in shape and setal pattern (Fig. 12 H).

NYMPH BIOLOGY.— Known only for *M. signata* that has a univoltine life cycle (Cather and Gaufin 1975, Allan 1982), with early instars appearing in Jul.–Oct., depending on elevation, then exhibiting a generally slow growth pattern. Most rapid growth occurs during summer (Allan 1982), and fall and early spring, correlating with greatest carnivory (Cather and Gaufin 1975). Nymphs are omnivorous (Cather and Gaufin 1975, Allan 1982), feeding primarily on diatoms, chironomids, and mayflies (Richardson and Gaufin 1971, Cather and Gaufin 1975, Peckarsky 1980, Peckarsky and Dodson 1980, Allan 1982). Nymphs prefer swift, aerated, stony-bottomed habitats in higher elevation streams (Dodds and Hisaw 1925, Knight 1965, Knight and Gaufin 1966, Stark et al. 1975). Adults emerge Apr.–Jul. (Gaufin et al. 1966, Cather and Gaufin 1975, Allan 1982).

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.— (1) *Megarcys irregularis* (Banks) — BC, WN, (2) *M. signata* — ALAS, BC, COL, ID, MONT, NEV, NM, UT, WYO, (3) *M. subtruncata* Hanson — BC, ID, MONT, ORE, WN, (4) *M. watertoni* (Ricker) — ALB, BC, ID, MONT, (5) *M. yosemite* (Needham & Claassen) — CAL, WN.

Oconoperla Stark & Stewart

TYPE SPECIES.— *Oconoperla weaveri* Stark & Stewart.

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.— Stark and Stewart (1982a; habitus, abdominal tergum 8 and detail of its setation, right mandible, lacinia, foreleg and magnified detail of its anterior aspect, basal antennal segments and detail of their setation. All illustrations SEMs except habitus.)

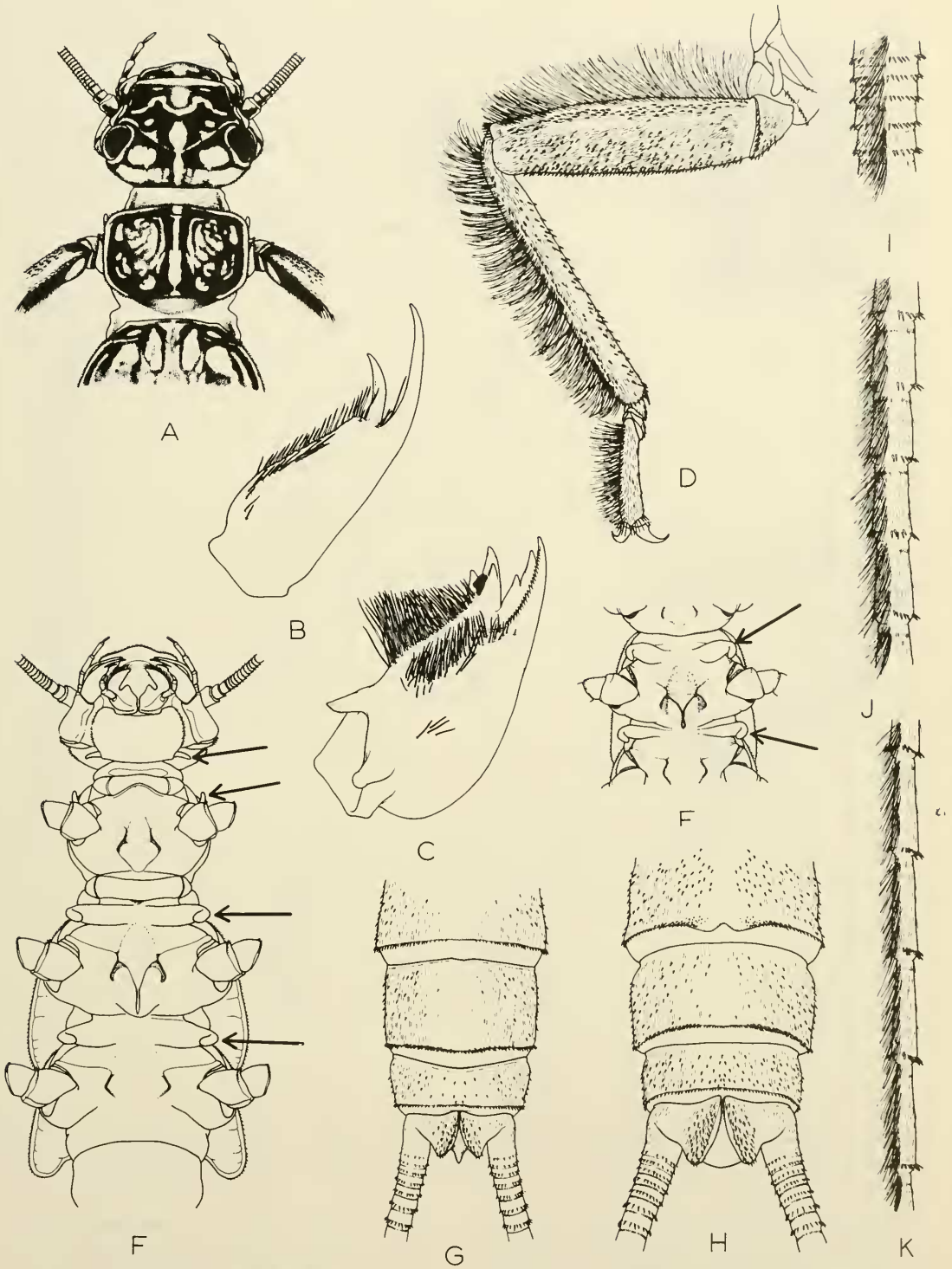


Fig. 12. Nymphal characters of *Megarcys signata*: A, head, pronotum pattern; B, left lacinia (ventral); C, left mandible (ventral); D, right front leg (anterior); E, submental and thoracic gills; F, mesosternal Y-pattern; G, ♂ ventral abdomen; H, ♀ ventral abdomen; I, J, K, basal, middle, and apical cercal segments (dorsal).

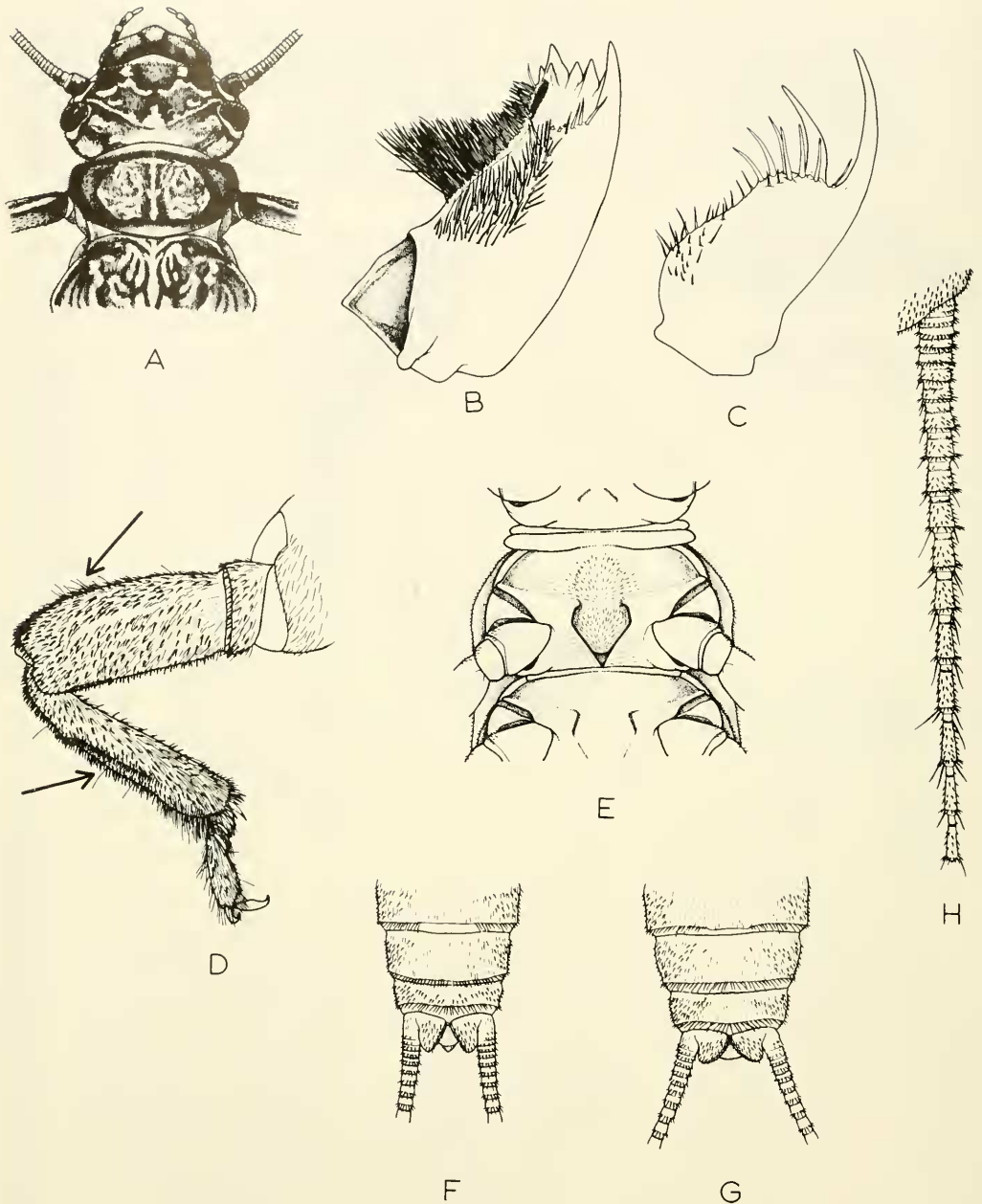


Fig. 13. Nymphal characters of *Oconoperla weaveri*: A, head, pronotum pattern; B, left mandible (ventral); C, left lacinia (ventral); D, right front leg (anterior); E, mesosternal Y-pattern; F, ♂ ventral abdomen; G, ♀ ventral abdomen; H, right cercus (dorsal).

NYPH DESCRIPTION.— (Figs. 13 A-H). Body brown, patterned with yellowish brown and covered with dark, wavy clothing hairs; membranous areas with purple-red pigment in living specimens; antennae, cerci yellowish brown. Head brown with pale M-mark for-

ward of anterior ocellus; pair of small, irregular light spots anterior and posterior to M-mark; light spot in interocellar triangle; occiput dark, with reticulate light markings; occipital spinules absent (Fig. 13 A). Laciniae bi-dentate with about 4-6 robust setae on a low

shoulder below subapical tooth, followed by about 12 marginal setae; 2 or 3 scattered submarginal setae and patch of 14–16 short, stout submarginal setae in basal half, and an axillary seta; setae absent from median ventral surface; terminal tooth about 0.4 total outer lacinial length, and strongly diverging subapical tooth about 0.7 length of terminal tooth (Fig. 13 C). Left mandible without deep cleft, serrations of teeth or median ventral setal patch; distinct row of acanthae near base of dorsal tooth, and 4 robust setae near base of ventral tooth (Fig. 13 B). Submental gills absent. Pronotum margined with short spinules and notched posterolaterally; its surface rugose and dark, with light reticulate pattern (Fig. 13 A). Y-arms of mesosternum meet posterior corners of furcal pits (Fig. 13 E). Mesometanota dark with light reticulate markings and covered with dark clothing hairs; margined laterally with short spinules (Fig. 13 A). Legs short, stout; outer (anterior) femoral surface brown with light, narrow longitudinal band, covered with socketed spinelike setae and wavy, dark clothing hairs; no fringe of silky hairs on femora or tibiae (Fig. 13 D). Abdominal terga brown, with mesal and lateral rows of paired light spots; surface densely covered with short, thick, curled setae and dark, flat clothing hairs; no distinct posterior fringe of setae. Cercal segments with apical whorl of setae; no dorsal, erect hairs or silky fringe; each segment with 3–5 stout, erect, long, apical setae ventrally (Fig. 13 H). Posterior setal row of male and female 8th abdominal sternum interrupted (Figs. 13 F, G), slight indication of developing subgenital plate in female (Fig. 13 G).

NYMPH BIOLOGY.— Unknown, except habitat is under rocks in splash zones of small spring seeps in North and South Carolina (Stark and Stewart 1982).

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.— Monospecific genus; *O. weaveri*— NC, SC.

Oroperla Needham

TYPE SPECIES.— *Oroperla barbara* Needham.

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.— Needham (1933; habitus), Ricker (1952; mandible, maxilla), Shepard and Stewart (1983; ventral habitus, gills).

NYMPH DESCRIPTION.— (Figs. 14 A–K). Body light brown with brown markings; dorsal surfaces covered with short, dark clothing hairs; erect white, silky hair fringe behind arms of ecdysial suture on head and as mesal longitudinal band on thorax and abdomen (Fig. 14 A); antennae brown, legs and cerci yellowish brown. Head mostly brown with pale and often interrupted, narrow, light M-mark forward of anterior ocellus; indistinct light spot in interocellar space and paired light occipital spots broken by reticulate dark lines; no occipital spinule row (Fig. 14 A). Laciniae triangulate, bidentate, with complete fringe of long inner marginal setae on apical $\frac{2}{3}$; 2 patches of submarginal setae at each end of marginal fringe; no median ventral patch of setae; terminal tooth about 0.4 total outer lacinial length and subapical tooth 0.5 length of terminal tooth (Fig. 14 B). Left mandible moderately cleft with large denticles on ventral tooth; median ventral setae absent (Fig. 14 C). Gills as follows: submental, short, simple anterior thoracic₁, double anterior thoracic₂ and AT₃, and simple ventrolateral on abdominal segments 1–7 (Fig. 14 D). Pronotum with about even light and dark reticulate pattern and no marginal setae (Fig. 14 A). Y-arms of mesosternum meet posterior corners of furcal pits (Fig. 14 F). Mesometanota with even, light and dark reticulate pattern, and no marginal setae or spinules (Fig. 14 A). Femora and tibiae without intercalary setae or spinules; covered with dark, wavy clothing hairs; with dense fringe of white, silky hairs (Fig. 14 E). Abdominal terga light brown with pairs of mesal and lateral small dark dots, and surface covered with minute dark freckles; lateral surfaces of gilled segments (Ab₁₋₇) are highly rugose; no apical tergal fringe of setae or intercalary spinules. Cercal segments with apical whorl of short setae and dense dorsal fringe of silky, white hairs (Figs. 14 I–K). No posterior setal fringe on male and female 8th abdominal sternae (Figs. 14 G, H); male 8th sternum with straight posterior margin (Fig. 14 G), and female with concave posterior margin on 8th sternum (Fig. 14 H).

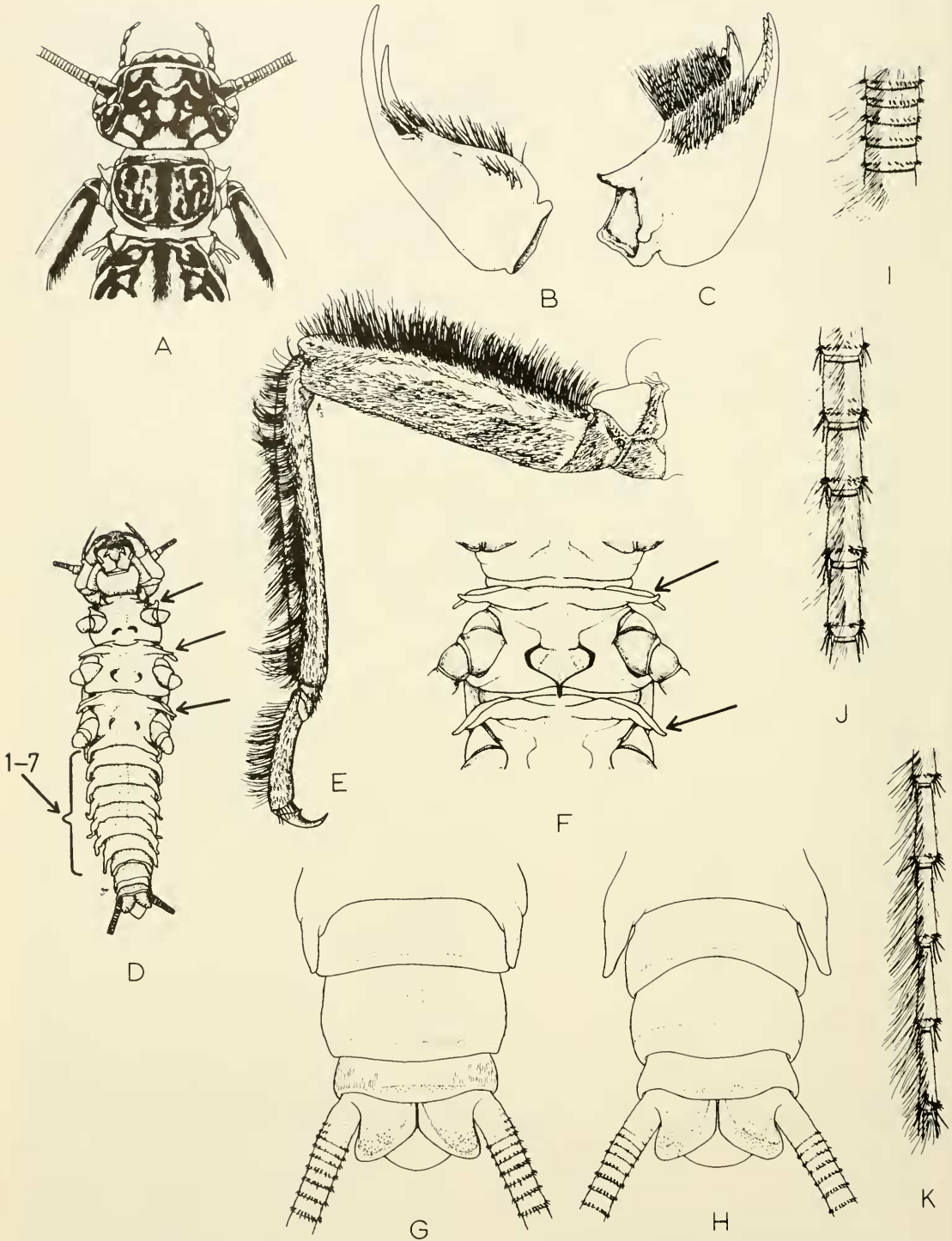


Fig. 14. Nymphal characters of *Ooperla barbara*: A, head, pronotum pattern; B, right lacinia (ventral); C, left mandible (ventral); D, ventrum, showing thoracic and abdominal gills; E, right front leg (anterior); F, mesosternal Y-pattern; G, ♂ ventral abdomen; H, ♀ ventral abdomen; I, J, K, basal, middle, and apical cercal segments (dorsal).

NYMPH BIOLOGY.—Relatively unknown. The species is apparently endemic to rivers of the Sierra Nevada Mts. of California (Ricker 1952, Jewett 1960, Jewett 1966). Nymphs collected in the Yuba river in March 1974 emerged in Apr.–May (Siegfried et al. 1977). Jewett (1966) observed captive nymphs ingesting smaller *Oroperla* and mayfly nymphs during the day.

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.—Monospecific genus; *O. barbara* — CAL.

Osobenus Ricker

TYPE SPECIES.—*Osobenus yakimae* (Hoppe)

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.—Jewett (1955; labium, abdomen, head-pronotum, maxilla).

NYMPH DESCRIPTION.—(Figs. 15 A–J). Body yellow with dark brown pattern; antennae, legs yellow; cerci light brown. Head yellow, with broad U-shaped brown marking, sometimes broken on anterior frons by hint of a light M-marking; narrow dark bar from eye toward foramen, containing 4 or 5 spinules near eye (Fig. 15 A). Laciniae bidentate with 1 or 2 axillary setae, 2 marginal setae just below subapical tooth and 4 or 5 short submarginal setae; no setae on median ventral surface; terminal tooth 0.5 total outer lacinial length and subapical tooth about 0.5 length of terminal tooth (Fig. 15 C). Left mandible without deep cleft, serrations of teeth, or median ventral setal patch; row of acanthae along inner base of dorsal tooth (Fig. 15 B). Gills absent. Pronotum encircled with broad brown band, leaving irregular diamond-shaped yellow center; no marginal setae or spinules (Fig. 15 A). Y-arms of mesosternum and transverse suture touch anterior corners of furcal pits (Fig. 15 E). Mesometanota with brown pigment bordering a central butterfly-shaped light spot; glabrous except for a few small anterior marginal setae (Fig. 15 A). Femora yellow with band of long setae at base of hair fringe, and scattered long anteroventral setae; dorsal fringe of yellow, silky hairs (Fig. 15 D). Tibiae with scattered stout intercalary setae and fringe of yellow, silky hairs (Fig. 15 D). Abdominal terga yellow with 2 broad longitudinal brown bands; pair of long

intercalary setae on segments 1–9 and 2 pair on segment 10; well-developed posterior setal fringe with longest setae mesally. Cercal segments with apical whorl of stout setae and dorsal fringe of yellow hairs (Figs. 15 H–J). Posterior setal row of male 8th abdominal sternum narrowly interrupted mesally (Fig. 15 F); 8th setal row of female interrupted about 0.3 width of sternum (Fig. 15 G).

NYMPH BIOLOGY.—Unknown, except found in large creeks and rivers, emerging in late May–early Jul.

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.—Monospecific genus; *O. yakimae* — BC, CAL, ORE, WN.

Perlinodes Needham & Claassen

TYPE SPECIES.—*Perlinodes aurea* (Smith).

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.—Ricker (1952), Baumann et al. (1977), Stark and Stewart (1982b; habitus, mandible, serrations of mandibular teeth, lacinia), Shepard and Stewart (1983; gills).

NYMPH DESCRIPTION.—(Figs. 16 A–K). Body brown, patterned with yellow and dorsal surfaces covered with short, stout spinules; tuft of erect, silky, yellow hairs on occiput and as mesal narrow band on thorax and abdomen (Fig. 16 A). Head mostly dark, with interrupted M-pattern forward of median ocellus, 2 light round spots lateral to ocellar triangle and light interocellar spot; 2 light round spots inside eyes, broken by dark reticulate lines; stout postocular spinules, occipital spinules not in a distinct row, continuous with other intercalary spinules of head (Fig. 16 A). Laciniae triangular, bidentate, with full fringe of marginal and submarginal setae, and distinct row of about 10 stout setae on low shoulder at base of apical tooth; no median ventral patch of setae; terminal tooth 0.3 total outer lacinial length and subapical tooth 0.67 length of terminal tooth (Fig. 16 B). Left mandible deeply cleft, with prominent serrations of teeth; median ventral patch of about 5 setae (Fig. 16 C). Paired simple gills present on submentum, anteroventral thorax, anterior supra-coxal₁, and anteroventral thorax_{2,3} (Fig. 16 F). Pronotum brown with light mesal stripe and reticulate light markings; margined by short, stout spinules. Y-arms of mesosternum meet posterior

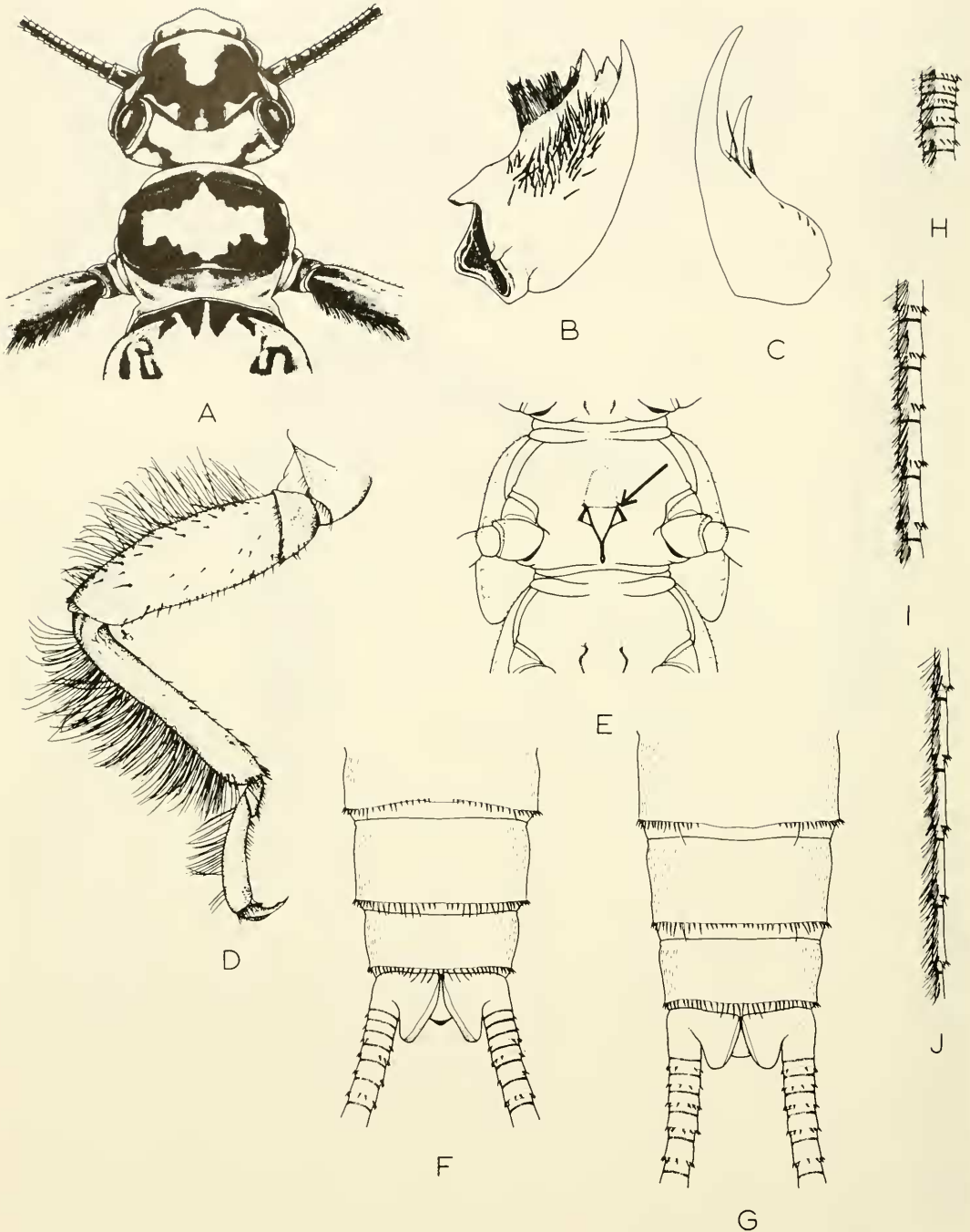


Fig. 15. Nymphal characters of *Osobenus yakamae*: A, head, pronotum pattern; B, left mandible (ventral); C, right lacinia (ventral); D, right front leg (anterior); E, mesosternal Y-pattern; F, ♂ ventral abdomen; G, ♀ ventral abdomen; H, I, J, basal, middle, and apical cercal segments (dorsal).

corners of furcal pits, and incomplete transverse arms reaching inward from anterior corners of furcal pits (Fig. 16 D). Meso-meta-

nota with brown pigment bordering a central butterfly-shaped light spot; a few small anterior marginal setae. Femora mostly brown

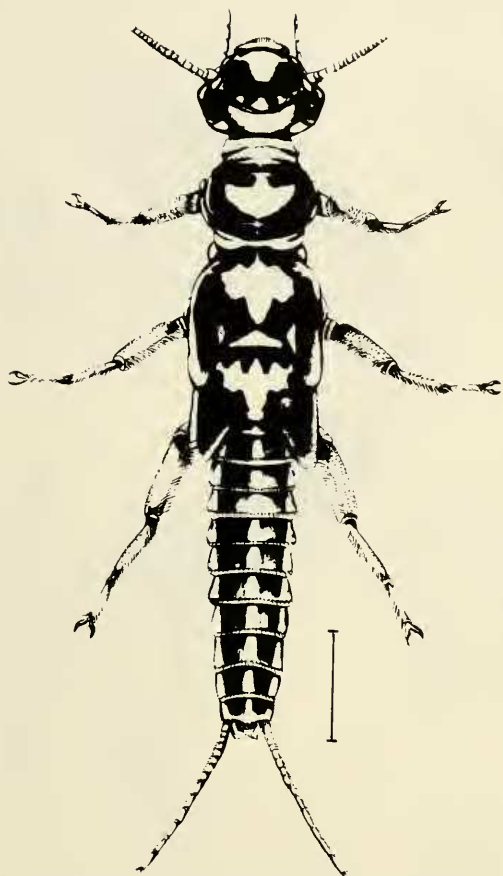


Fig. 15K. *Osobenus yakamae*: nymph habitus; scale line = 2 mm.

with light mesal longitudinal bar; stout spinules on brown areas, and dorsal fringe of yellow, silky hairs; tibiae with row of spinules at base of yellow, silky hair fringe and few dorsal intercalary spinules (Fig. 16 E). Abdominal tergae brown with mesal and lateral pairs of small yellow spots; dense intercalary spinules and posterior row of stout, dark brown spinules. Cercal segments dark brown, with apical whorl of stout spinules and dorsal fringe of silky, yellow hairs (Fig. 16 I-K). Posterior setal row and intercalary spinules of male 8th abdominal sternum interrupted (Fig. 16 G); female with developing subgenital plate and narrowly interrupted posterior setal row on 8th sternum (Fig. 16 H).

NYMPH BIOLOGY.— Relatively poorly known. Sheldon (1972) found *P. aurea* to be the rarest of the perlodid complex studied at Sagehen Creek, but the species displayed higher densities in lower reaches of the stream. Growth of nymphs was similar to

other perlodids studied, but emergence was slightly earlier (Apr.-Jun.) than for other perlodids. Nymphs fed primarily on smaller Diptera found among periphyton.

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.— Monospecific genus; *P. aurea* — ALB, CAL, ID, MONT, ORE, WN, WYO.

Pictetiella Illies

TYPE SPECIES.— *Pictetiella expansa* (Banks).

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.— Claassen (1931), Ricker (1952; maxilla), Baumann (1973; habitus, galea tip, left maxilla, left and right mandible), Baumann et al. (1977).

NYMPH DESCRIPTION.— (Figs. 17 A-I). Body yellow with light brown markings, sparse tufts of erect silky, yellow hairs behind ecdysial suture of head and as a mesal band on thorax and abdomen; antennae, legs yellow; cerci yellow basally, dark brown apically. Head with M-mark forward of anterior ocellus, small spots lateral to ocellar triangle and largely light interocellar area; 2 large occipital yellow spots inside eyes, bordered behind by incomplete sinuate row of 8-10 spinules (Fig. 17 A). Laciniae triangular, bidentate, with 8-10 scattered marginal setae, about 8 submarginal setae, and 2 axillary setae; median ventral setal patch absent; terminal tooth about 0.45 total outer lacinial length and subapical tooth about 0.6 length of terminal tooth (Fig. 17 C). Left mandible not deeply cleft, teeth without distinct serrations, and no median ventral patch of setae (Fig. 17 B). Projecting portion of submental gills about 2 times their basal diameter (Fig. 17 E). Pronotum with reticulate pattern, nearly complete mesal light band, and light marginal border; marginal setae on anterior and posterior margins, longest on corners and absent on 0.5 of lateral margin (Fig. 17 A). Y-arms of mesosternum meet posterior corners of furcal pits (Fig. 17 F). Meso-metana mostly dark with pair of light round spots; transverse spinule row along front ridge of wingpads, continuous with lateral marginal spinules (Fig. 17 A). Femora with band of stout setae along base of dorsal fringe and on anteroventral surface; dorsal fringe of golden, silky hairs (Fig. 17 D); tibiae with more than 50 dorsal intercalary spinules and

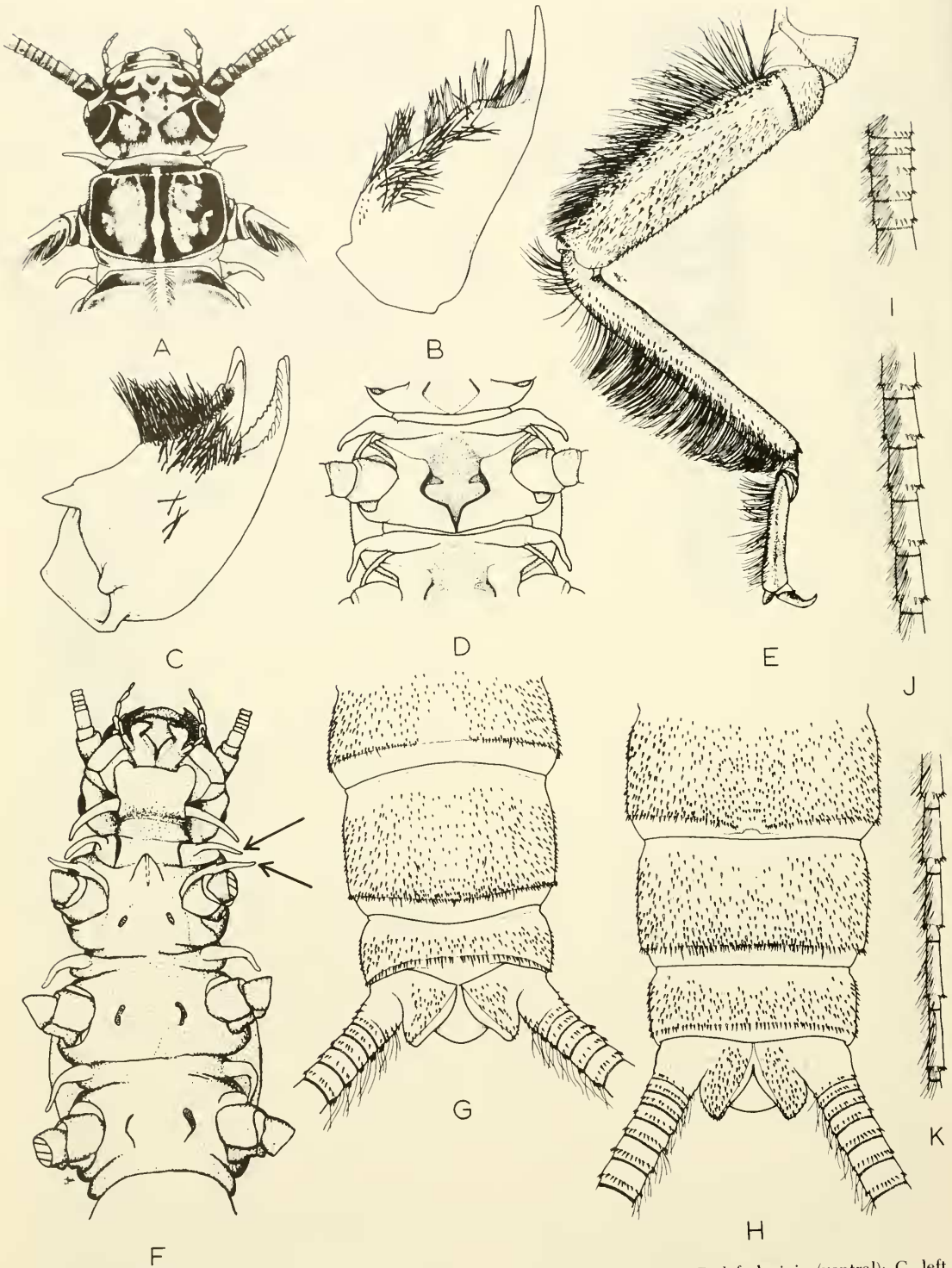


Fig. 16. Nymphal characters of *Perlínodes aurea*: A, head, pronotum pattern; B, left lacinia (ventral); C, left mandible (ventral); D, mesosternal Y-pattern; E, right front leg (anterior); F, submental, anterior thoracic, and thoracic gills; G, ♂ ventral abdomen; H, ♀ ventral abdomen; I, J, K, basal, middle, and apical cercal segments (dorsal).

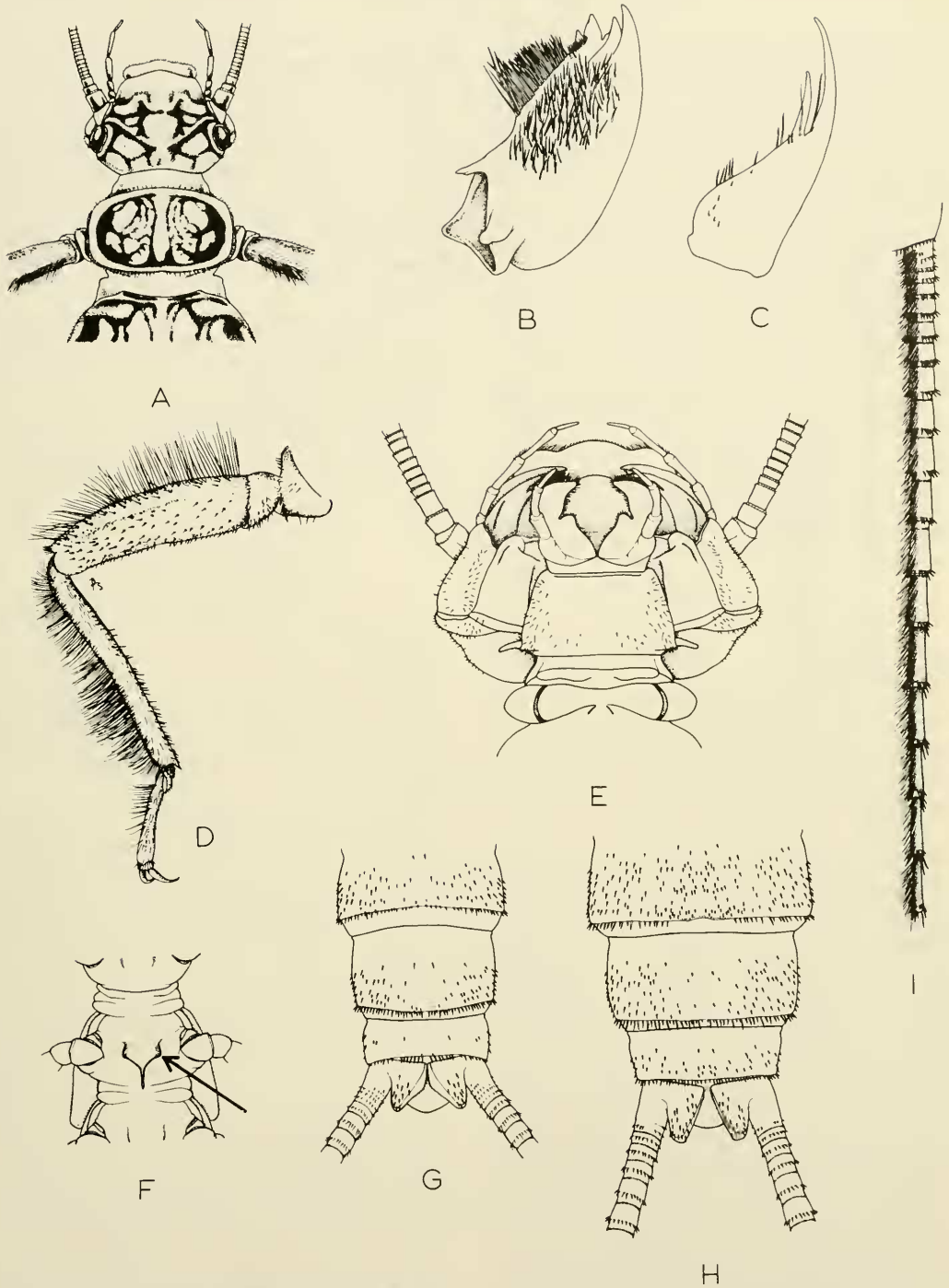


Fig. 17. Nymphal characters of *Pictetiella expansa*: A, head, pronotum pattern; B, left mandible (ventral); C, left lacinia (ventral); D, right front leg (anterior); E, submental gills; F, mesosternal Y-pattern; G, ♂ ventral abdomen; H, ♀ ventral abdomen; I, basal right cercal segments (dorsal).

fringe of golden, silky hairs (Fig. 17 D). Abdominal terga brown, with more than 100 intercalary spinules, and well-developed poste-

rior fringe of stout setae, longest ones mesally. Cercal segments with apical whorl of stout setae and dorsal fringe of golden,

silky hairs; cerci bicolored, with basal segments yellow and apical segments dark brown (Fig. 17 I). Posterior setal row of male 8th abdominal sternum continuous (Fig. 17 G); female with interrupted posterior 8th setal row and slight indication of developing subgenital plate (Fig. 17 H).

NYMPH BIOLOGY.— Poorly known. Found in streams 9000–9700 ft elevation in Colorado (Dodds and Hisaw 1975, and unique among the Perlodinae in having a late summer to fall emergence (July–Oct.) (Baumann and Gaufin 1969, Baumann et al. 1977). We successfully reared several mature nymphs collected near Provo, Utah, 31 Jul. 1982 within a period of 3 weeks.

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.— Monospecific genus; *P. expansa* — COL, ID, MONT, UT, WYO.

Remenus Ricker

TYPE SPECIES.— *Remenus bilobatus* (Needham & Claassen).

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.— Claassen (1931; labrum, mandible, maxilla, labium), Frison (1942; habitus, mandible, maxilla, labium). Ricker (1952), Hitchcock (1974).

NYMPH DESCRIPTION.— (Figs. 18 A–J). Small; mature nymph less than 10 mm; body yellowish brown with little discernible pattern. Head with very faint M-mark forward of anterior ocellus; no distinct row of occipital spinules; 2–4 erect, stiff postocular setae (Fig. 18 A). Laciniae unidentate, abruptly narrowed near base (Fig. 18 C). Left mandible not deeply cleft, without serrations of teeth or median ventral setal patch (Fig. 18 B). Gills absent. Pronotum with faint reticulate pattern; 10–14 long erect marginal setae on each side (Fig. 18 A). Y-arms of mesosternum reach posterior corners of furcal pits (Fig. 18 E). Meso-metanota with faint reticulate pattern and dark brown wingpads; 1–3 erect setae anterolaterally, and a few short marginal setae (Fig. 18 A). Femora with stout, long setae over surface, but lacking a silky hair fringe (Fig. 18 D); tibiae with 10 or fewer short dorsal intercalary setae, and row of setae along base of well-developed golden, silky hair fringe (Fig. 18 D). Abdominal terga light brown, with fewer than 20 intercalary

setae and posterior fringe of setae of alternate lengths, longest about 0.5 length of tergum. Cercal segments with apical whorl of long setae, some longer than following segment; no dorsal cercal silky fringe (Figs. 18 F–J). Posterior setal row of both male and female 8th abdominal sternum interrupted mesally (Figs. 18 F, G), but mature male nymph with elongate terminal process (Fig. 18 F).

NYMPH BIOLOGY.— Unknown except emergence is in Jun. in Great Smoky Mt. National Park (Frison 1942) and in West Virginia (R. F. Kirchner collection).

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.— Monospecific genus; *R. bilobatus* — CONN, DEL, GA, NC, NY, PA, SC, TN, VA, WV.

Rickera Jewett

TYPE SPECIES.— *Rickera sorpta* (Needham & Claassen).

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.— Jewett (1955; head-pronotum, maxilla, labium), Szczytko and Stewart (1984; habitus, mandibles, laciniae, mesosternum, cerci).

NYMPH DESCRIPTION.— (Figs. 19 A–J). Body light brown with brown markings; antennae, legs cerci light brown. Head with dark, broad, irregular U-shaped mark connecting ocelli; light oval interocellar spot; light area anterior to median ocellus, sometimes with faint posterolateral arms forming an M-pattern (Fig. 19 A). Laciniae triangular and unidentate, with 5–6 basal marginal spinules and 2–3 medially located marginal spinules (Fig. 19 B). Left mandible not deeply cleft, teeth without serrations, and no separated median ventral patch of setae; dense row of unsocketed acanthae below dorsal tooth (Fig. 19 C). Gills absent. Pronotum encircled with light margin, then narrow dark band and coarsely reticulate interior pattern; glabrous, without setae or spinules (Fig. 19 A). Y-arms of mesosternum meet posterior corners of furcal pits, and transverse suture connects anterior corners of furcal pits (Fig. 19 E). Meso-metanota glabrous without hairs or spinules. Femora yellowish brown with darker dorsal spot in apical half; band of setae 3–4 wide at

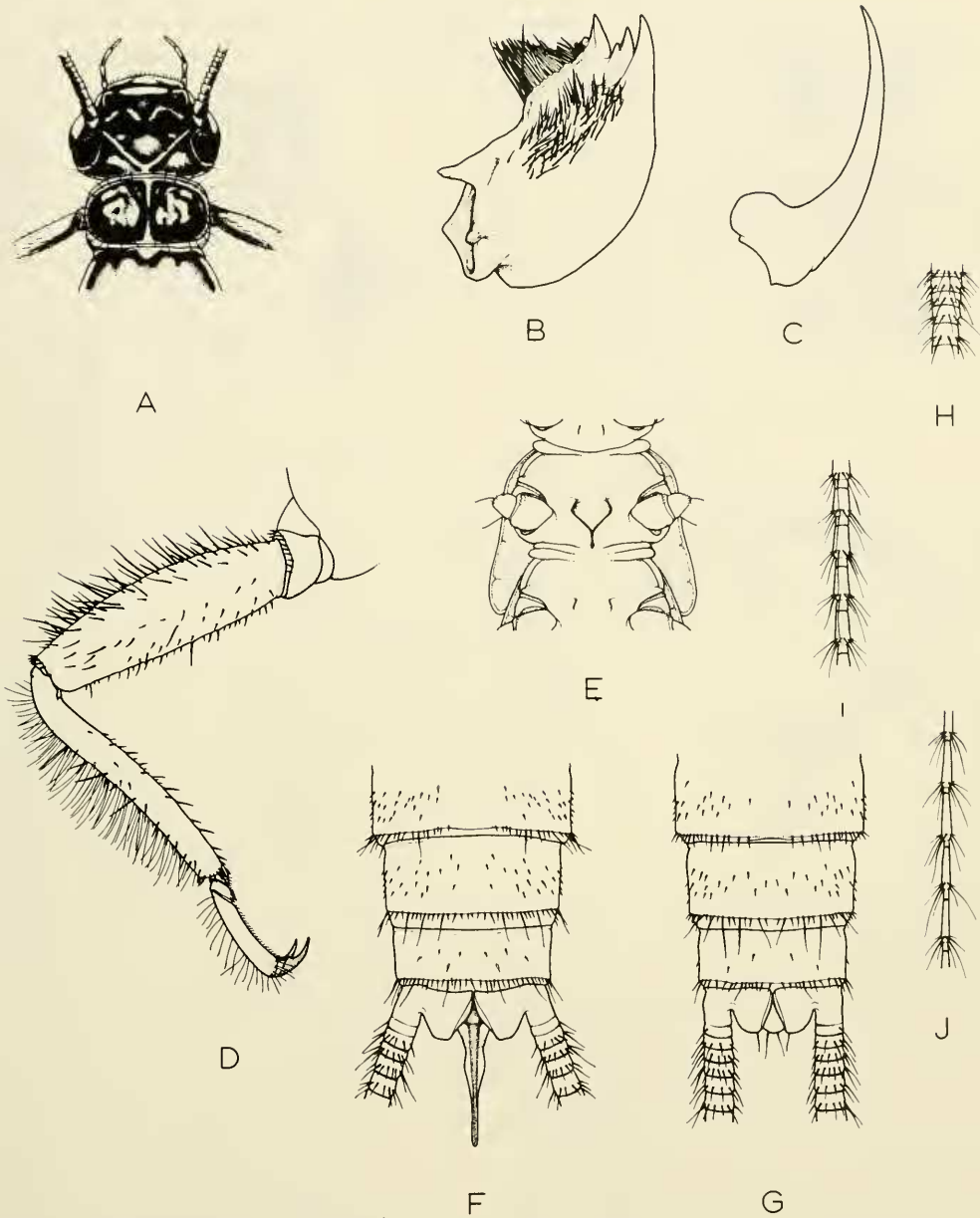


Fig. 18. Nymphal characters of *Remenus bilobatus*: A, head, pronotum pattern; B, left mandible (ventral); C, left lacinia (ventral); D, right front leg (anterior); E, mesosternal Y-pattern; F, ♂ ventral abdomen and terminalia; G, ♀ ventral abdomen; H, I, J, basal, middle, and apical cercal segments (dorsal).

base of golden, silky hair fringe, and scattered over dorsal surface; tibial setal pattern similar to femora, and with golden, silky hair fringe (Fig. 19 D). Abdominal terga with light mesal spot margined by brown, giving abdomen the appearance of having a wide, light mesal band; segments 1-4 with fewer than 10 intercalary spinules and segments

5-10 with increasing number of intercalary spinules, up to 24-26. Cercal segments with apical whorl of stout setae and short dorsal fringe of golden, silky hairs (Figs. 19 H-J). Posterior setal row of male and female 8th abdominal sternae interrupted (Figs. 19 F, G); mesal posterior margin of female 8th sternum shallowly notched and sternae 8-10

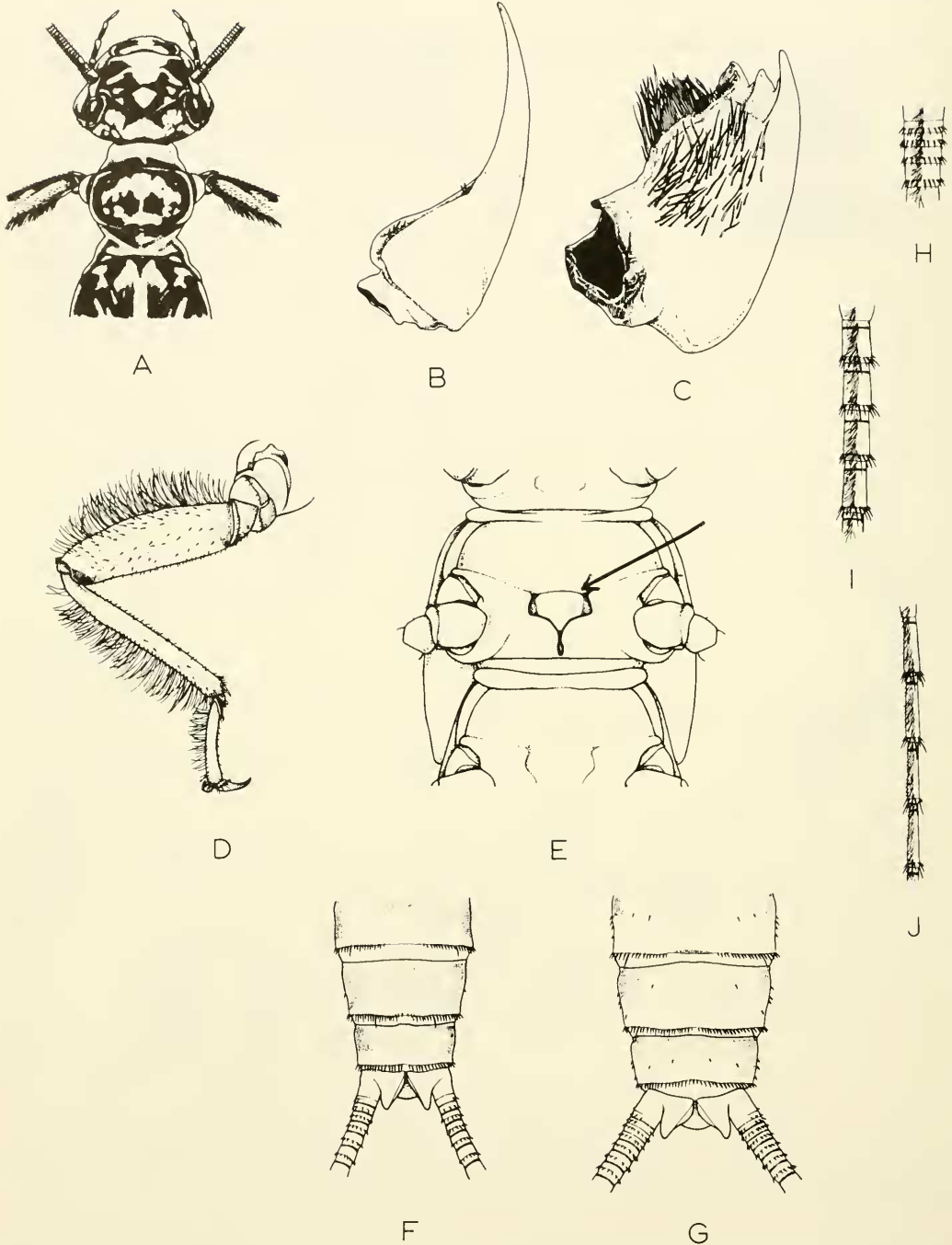


Fig. 19. Nymphal characters of *Rickeria sorpta*: A, head, pronotum pattern; B, left lacinia (ventral); C, left mandible (ventral); D, right front leg (anterior); E, mesosternal Y-pattern; F, ♂ ventral abdomen; G, ♀ ventral abdomen; H, I, J, basal, middle, and apical cercal segments (dorsal).

with a few stout lateral intercalary spinules (Fig. 19 G).

NYMPH BIOLOGY.—Unknown, except that emergence occurs in early to mid-Jun. (Shel-

don & Jewett 1967) to Jul. We reared adults from mature nymphs collected 6 Jul. 1979 in Hat Creek, Lassen Volcanic National Park, California.

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.— Monospecific genus; *R. sorpta* —CAL, ORE, WN.

Setvena Illies

TYPE SPECIES.— *Setvena bradleyi* (Smith).

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.— (1) *S. tibialis* — Ricker (1952), Baumann et al. (1977). Nymphal characters have not been previously illustrated, except the gills (Shepard and Stewart 1983), (2) *S. bradleyi* — Claassen (1931; labrum, mandibles, maxilla, labium).

NYMPH DESCRIPTION.— (*S. bradleyi*) (Figs. 20 A–K). Body brown with dark brown pattern; dorsal surfaces with scattered small dark clothing hairs; antennae, legs, cerci brown. Frons, including interocellar area, brown, with faint lighter M-mark forward of anterior ocellus; occiput light brown with sinuate transverse row of stout spinules (Fig. 20 A). Lacinae triangular, bidentate with tuft of long setae on low knob below subapical tooth and continuous row of inner marginal setae, group of submarginal setae basally and 2 stout axillary setae; terminal tooth .035 total outer lacinial length and subapical tooth about 0.5 length of terminal tooth (Fig. 20 B). Left mandible not deeply cleft, without serrations of teeth; median ventral patch of about 10 setae, and separate inner marginal patch of setae basally (Fig. 20 C). Short submental gills about 1.5–2.0 times as long as their basal diameter and fingerlike, simple gills anteroventrally on the meso- and metasternae (Fig. 20 F). Pronotum light brown with narrow, irregular, lighter mesal bar, lateral dark longitudinal bars and light interior reticulate markings; small spinules along front margin, absent along lateral and posterior margins (Fig. 20 A). Y-arms of mesosternum meet posterior corners of furcal pits and sinuate transverse furrow connecting anterior corners of furcal pits (Fig. 20 D). Meso- and metanota with a pair of light, central irregular round spots and other smaller light reticulate markings; transverse row of dark spinules across front ridge of wingpads; lateral marginal spinules small (Fig. 20 A). Femora brown with band of setae along base of golden, silky hair fringe and short setae and spinules along lower anterior surface; anterior

(dorsal) surface covered with dark clothing hairs, except mesal band; tibiae covered with numerous stout intercalary setae and row of setae along base of golden, silky hair fringe (Fig. 20 E). Abdominal terga brown with >100 intercalary spinules; posterior fringe of setae on segments 1–7 restricted to mesal 1/3, but complete on segments 8–10, longest mesally. Cercal segments with apical whorl of short setae and dorsal fringe of golden, silky hairs (Figs. 20 I–K). Posterior setal row of male 8th abdominal sternum narrowly interrupted (Fig. 20 G); female 8th posterior setal row interrupted and posterior margin of 8th sternum with developing subgenital plate mesally (Fig. 20 H).

NYMPH BIOLOGY.— Unknown, except emergence of both species is during summer, Jun.–Aug. (Baumann et al. 1977, Jewett 1959). We reared one female *S. bradleyi* from a mature nymph collected 26 June 1981 in Teepee Creek, Lake Co., Montana.

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.— (1) *S. bradleyi* — ALB, BC, ID, MONT, (2) *S. tibialis* (Banks) — BC, ORE, WN.

Skwala Ricker

TYPE SPECIES.— *Skwala parallela* (Frison).

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.— (1) *S. curvata* — none, (2) *S. parallela* — Claassen (1931), Frison (1942; habitus, mandible, maxilla, labium), Ricker (1952), Baumann et al. (1977), Dosdall and Lehmkühl (1979; left mandible, mesosternum), Shepard and Stewart (1983; gills).

NYMPH DESCRIPTION.— (*S. parallela*) (Figs. 21 A–K). Body yellowish brown with brown markings; sparse row of erect white, silky hairs behind ecdysial suture of head and as mesal row on thorax and abdomen; antennae, legs, cerci brown. Head dark with lighter M-mark forward of anterior ocellus and incomplete light mesal bar; 2 oval, light occipital spots inside eyes, broken with reticulate dark lines and bordered behind by narrow band of stout spinules (Fig. 21 A). Lacinae bidentate with tuft of setae on a low knob below subapical tooth and continuous inner row of marginal setae; complete band of submarginal setae; no separate median ventral patch of setae; terminal tooth about 0.4 total

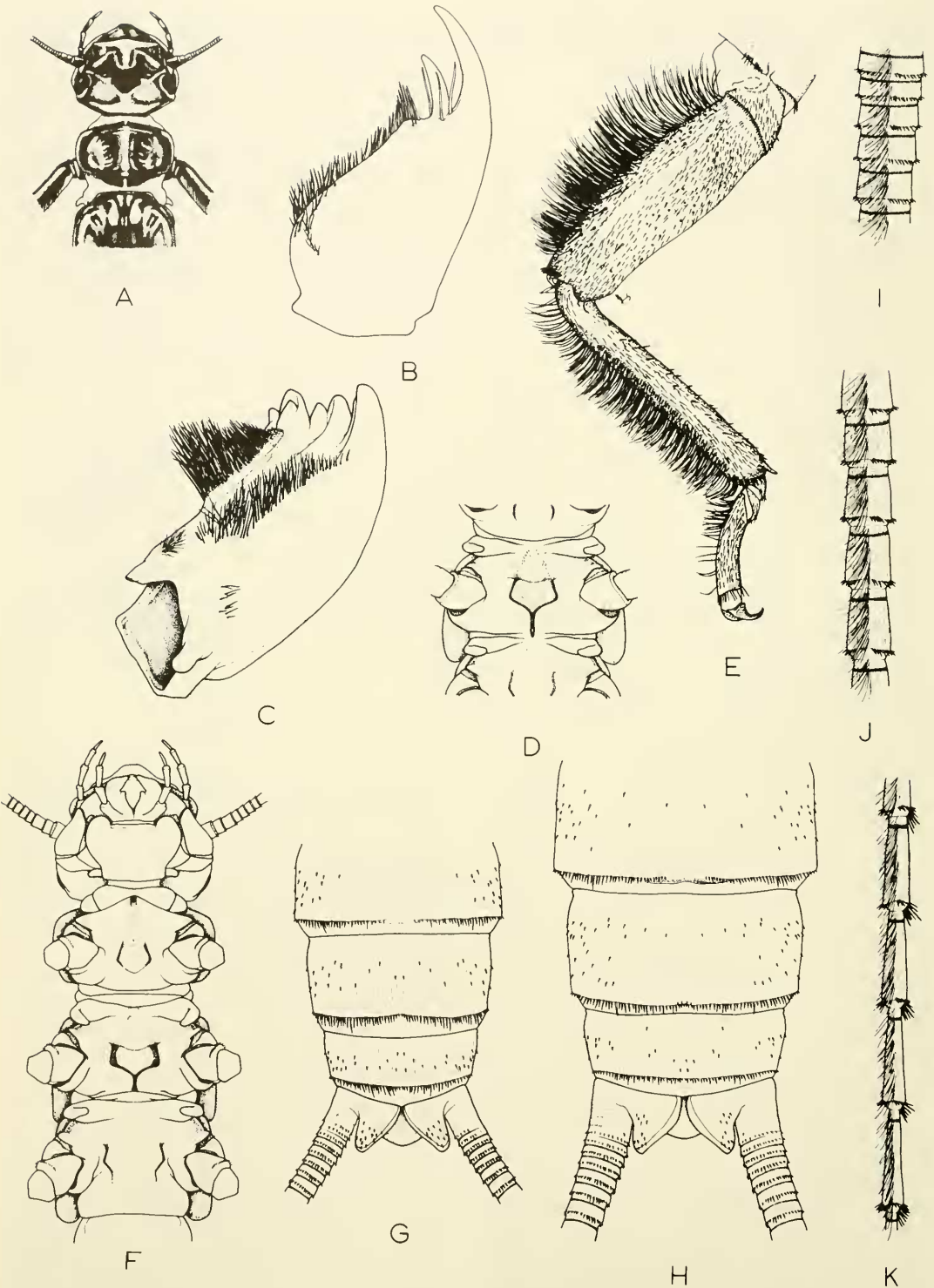


Fig. 20. Nymphal characters of *Setvena bradleyi*: A, head, pronotum pattern; B, left lacinia (ventral); C, left mandible (ventral); D, mesosternal Y-pattern; E, right front leg (anterior); F, submental and thoracic gills; G, ♂ ventral abdomen; H, ♀ ventral abdomen; I, J, K, basal, middle, and apical cercal segments (dorsal).

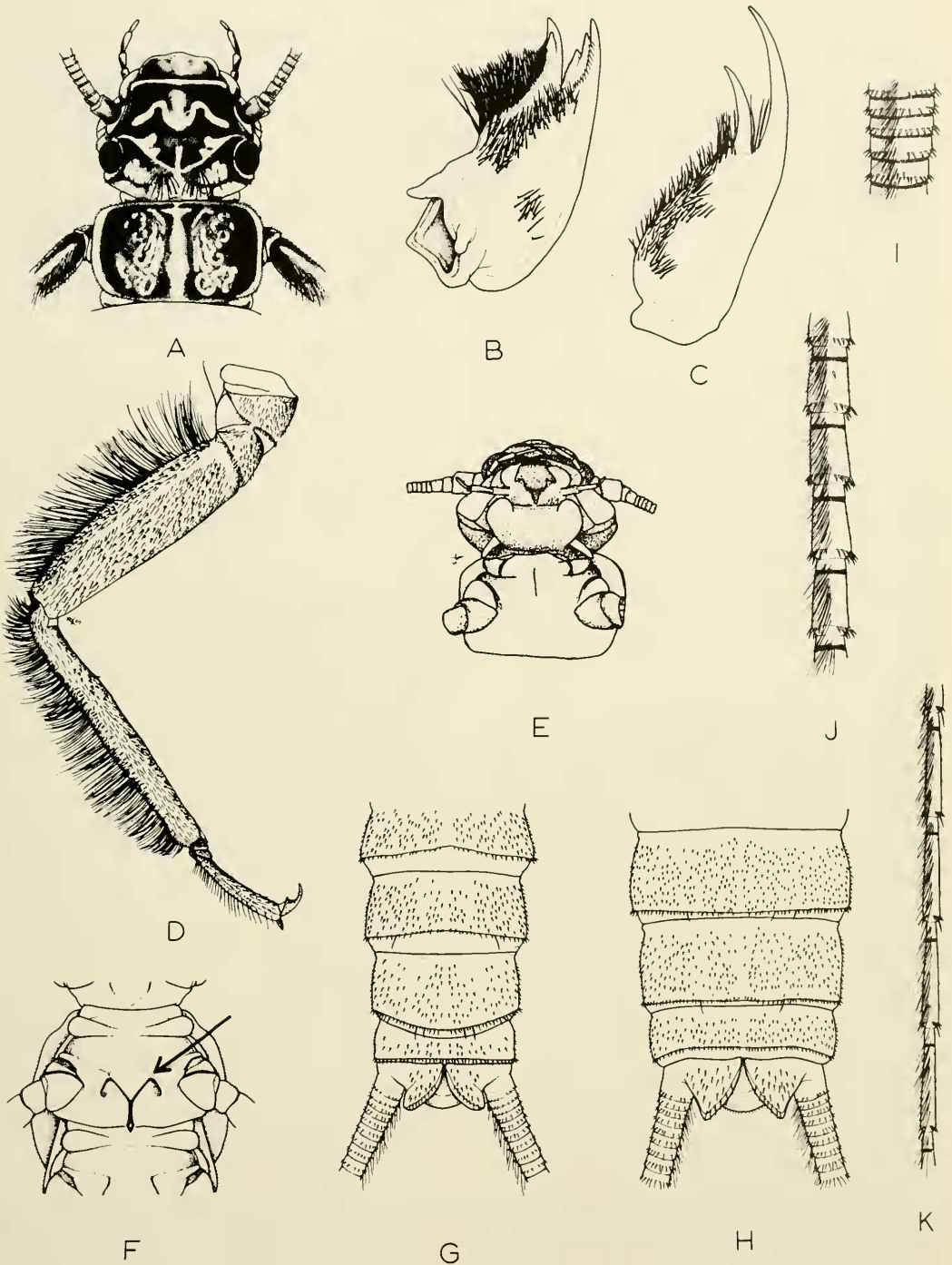


Fig. 21. Nymphal characters of *Skwala parallela*: A, head, pronotum pattern; B, left mandible (ventral); C, left lacinia (ventral); D, right front leg (anterior); E, submental gills; F, mesosternal Y-pattern; G, ♂ ventral abdomen; H, ♀ ventral abdomen; I, J, K, basal, middle, and apical cercal segments (dorsal).

outer lacinial length and subapical tooth about 0.6 length of terminal tooth (Fig. 21 C). Left mandible not deeply cleft; ventral

teeth with well-developed serrations and median ventral patch of 12-14 setae present (Fig. 21 B). Long submental gills, projecting

portion about 2.5–3.0 times as long as their basal diameter (Fig. 21 E). Pronotum dark with light lateral margins, light mesal band and light reticulate interior markings; complete row of short marginal spinules (Fig. 21 A). Y-arms of mesosternum reach anterior corners of furcal pits (Fig. 21 F). Meso- and metanota with irregular reticulate markings, darker areas with intercalary spinules; short setae across anteriormost transverse ridge of wingpads, continuous with lateral marginal setae. Legs brown, dorsal surfaces of femora and tibiae covered with short, stout setae, and both with golden, silky hair fringe (Fig. 21 D). Abdominal terga brown with mesal and lateral pairs of small light spots; densely covered with intercalary setae (>200) and margined posteriorly with a close-set row of short, stout setae. Cercal segments with apical whorl of short, stout setae and dorsal fringe of golden, silky hairs (Figs. 21 I–K). Posterior setal row of male 8th abdominal sternum more or less continuous (Fig. 21 G); female 8th setal row narrowly interrupted (Fig. 21 H).

NYPH BIOLOGY.—Relatively well known for *S. parallela* and more generally for *S. curvata*. Univoltine in Colorado, with growth most rapid in late summer and fall; growth slows in winter but is continuous to Feb.–Apr., when emergence occurs (Short and Ward 1980). Young nymphs in Sep. in the Gunnison River, Colorado, were highly carnivorous, feeding predominantly on and showing positive electivity for Chironomidae larvae (Fuller and Stewart 1977). The diets of mature nymphs in early May were 75% animal matter, primarily mayfly and stonefly nymphs (Fuller and Stewart 1977). Richardson and Gaufin (1971) found that 41 fed guts of mature nymphs in Mar.–April contained 58.7% animal matter, primarily chironomids and mayfly nymphs, and 40.2% of a combination of detritus, filamentous green algae, and diatoms. The species is found primarily in foothill and lower-elevation rivers (Knight and Gaufin 1966, 1967, Ricker 1964), and generally emergence occurs Feb.–Jul., depending on altitude and latitude (Jewett 1959, Gaufin et al. 1972, Baumann et al. 1977, Short and Ward 1980). Sheldon (1972) found *S. curvata* to be the most abundant perlotid in Sagehen Creek. Small nymphs appear in

late Jun. and display continuous growth until emergence from Apr. through early Jun. Nymphs fed on a variety of animal matter including Diptera, Ephemeroptera, Plecoptera, and Trichoptera.

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.—(1) *Skwala curvata* (Hanson) — BC, ID, MONT, ORE, WN, WYO, (2) *S. parallela* — ARIZ, BC, CAL, COL, ID, MONT, NEV, NM, ORE, SASK, UT, WN, WYO.

Yugus Ricker

TYPE SPECIES.—*Yugus bulbosus* (Frison).

PREVIOUS NYMPH DESCRIPTIONS/ILLUSTRATIONS.—(1) *Y. arinus* — Frison (1942; habitus, mandible, maxilla, labium), (2) *Y. bulbosus* — Frison (1942; habitus, mandibles, maxillae, labium), Ricker (1952), (3) *Y. innubilus* — none.

NYMPH DESCRIPTION.—(*Y. bulbosus*) (Figs. 22 A–J). Body yellow with light brown pattern; antennae, legs, cerci yellow. Head with light M-mark forward of anterior ocellus, bordered on front and rear with brown; interocellar area and area forward of ecdysial arms yellow; occiput with 2 light oval spots inside eyes, faintly broken by brown lines and partially bordered behind by an outer transverse band of spinules 2–4 wide (Fig. 22 A). Laciniae triangular, bidentate, with tuft of stout setae on low knob below subapical tooth and continuous inner row of stout marginal setae; 1 or 2 axillary setae and transverse band of setae across basal ventral surface; terminal tooth strongly curved, about 0.33 total outer lacinial length and subapical tooth about 0.5 length of terminal tooth (Figs. 22 C). Left mandible not deeply cleft, ventral teeth with barely discernible shallow serrations; no median ventral patch of setae (Fig. 22 B). Small nipplelike projection at posterior corners of submentum in some species we examined was suggestive of a very short or atrophied submental gill (also noted by Frison 1942); in other specimens submental gills were absent (also noted by Ricker 1952, Shepard and Stewart 1983). Pronotum encircled with narrow, light marginal band; mesal longitudinal light band and light reticulate interior markings; margined with short setae (Fig. 22 A). Y-arms of mesosternum meet posterior corners of furcal pits and

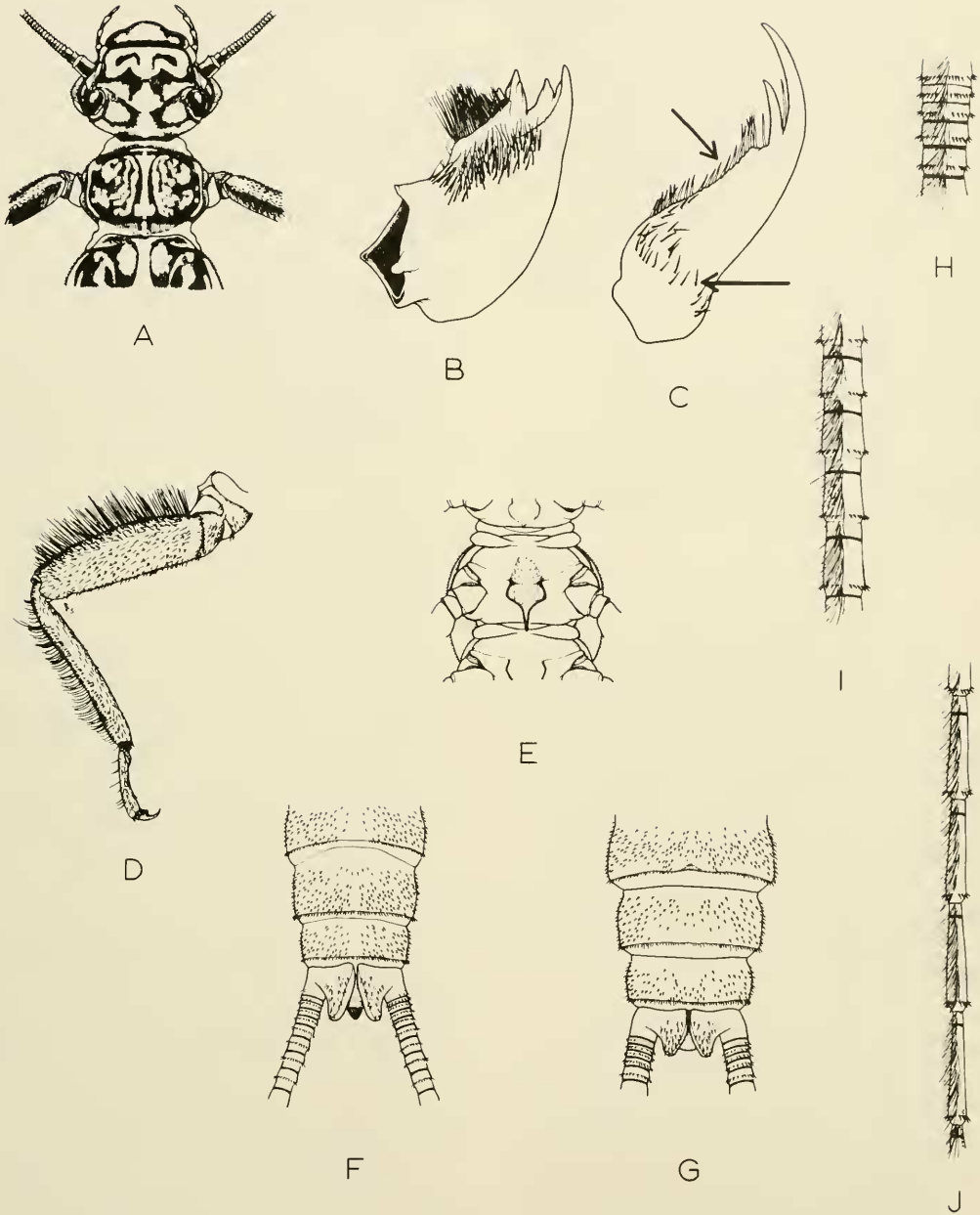


Fig. 22. Nymphal characters of *Yugus bulbosus*: A, head, pronotum pattern; B, left mandible (ventral); C, left maxilla (ventral); D, right front leg (anterior); E, mesosternal Y-pattern; F, ♂ ventral abdomen; G, ♀ ventral abdomen; H, I, J, basal, middle, and apical cercal segments (dorsal).

a faint incomplete transverse furrow is evident in some, with arms extending a short way inside anterior corners of furcal pits (Fig. 22 E). Meso-metanota with mesal light band and 2 round spots inside base of wingpads; transverse band of spinules along front

ridge of wingpads and short lateral marginal spinules present (Fig. 22 A). Anterior femoral surface with short, stout intercalary setae and dark clothing hairs, except along mesal longitudinal bar; dorsal fringe of yellow, silky hairs; tibiae with hair pattern similar to fe-

mora (Fig. 22 D). Abdominal terga light brown except pair of yellow spots, giving the abdomen an appearance of having a central, broad, light longitudinal band; terga with >50 intercalary spinules and posterior row of short setae. Cercal segments with apical whorl of short setae and dorsal fringe of yellow, silky hairs (Figs. 22 H-J). Posterior setal row of male and female 8th abdominal sterna interrupted mesally (Figs. 22 F, G); female posterior margin of 8th sternum shallowly notched mesally at developing subgenital plate (Fig. 22 G).

NYMPH BIOLOGY.— Unknown, except emergence occurs Apr.—early Jun.

NORTH AMERICAN SPECIES LIST/DISTRIBUTION.— (1) *Yugus arinus* (Frison) — GA, NC, TN, VA, (2) *Y. bulbosus* — GA, NC, PA, SC, TN, VA, WV, (3) *Y. innubilis* (Needham & Claassen) — NC, TN

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